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**INTERIM REPORT**  
**July 16, 1993**

**FOR**

**BIOVENTING FIELD INITIATIVE**

**AT**

**KEESLER AIR FORCE BASE, MISSISSIPPI**

**to**

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**INTERIM REPORT**  
**BIOVENTING FIELD INITIATIVE**  
**KEESLER AIR FORCE BASE, MISSISSIPPI**

**1.0 INTRODUCTION**

This report describes the activities conducted at Keesler AFB, Mississippi, as part of the Bioventing Field Initiative for the U.S. Air Force Center for Environmental Excellence (AFCEE) and the Environmental Quality Directorate of the Air Force Armstrong Laboratory. This report summarizes the results from the first phase of the study at Keesler AFB. First-phase activities include a soil gas survey, air permeability test, in situ respiration test, and installation of bioventing systems. The specific objectives of this Bioventing Field Initiative are described in the following section. Each site at the base is discussed individually, followed by a description of site activities at the background area.

**1.1 Objectives**

The purpose of this Bioventing Field Initiative is to measure the soil gas permeability and microbial activity at a contaminated site in order to evaluate the potential application of bioventing technology to remediate the site. The specific test objectives are stated below.

- A small-scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. Soil gas from the candidate site should exhibit high total petroleum hydrocarbon (TPH) concentrations, relatively low oxygen concentrations, and relatively high carbon dioxide concentrations. An uncontaminated background location also will be identified.
- The soil gas permeability of the soil and the air vent (well) radius of influence will be determined. To measure these parameters, air will be withdrawn or injected for approximately 8 hours at vent wells located in contaminated soils. Pressure changes will be monitored in an array of monitoring points.
- Immediately following the soil gas permeability test, an in situ respiration test will be conducted. Air will be injected into selected monitoring points to

aerate the soils. The in situ oxygen utilization and carbon dioxide production rates will be measured.

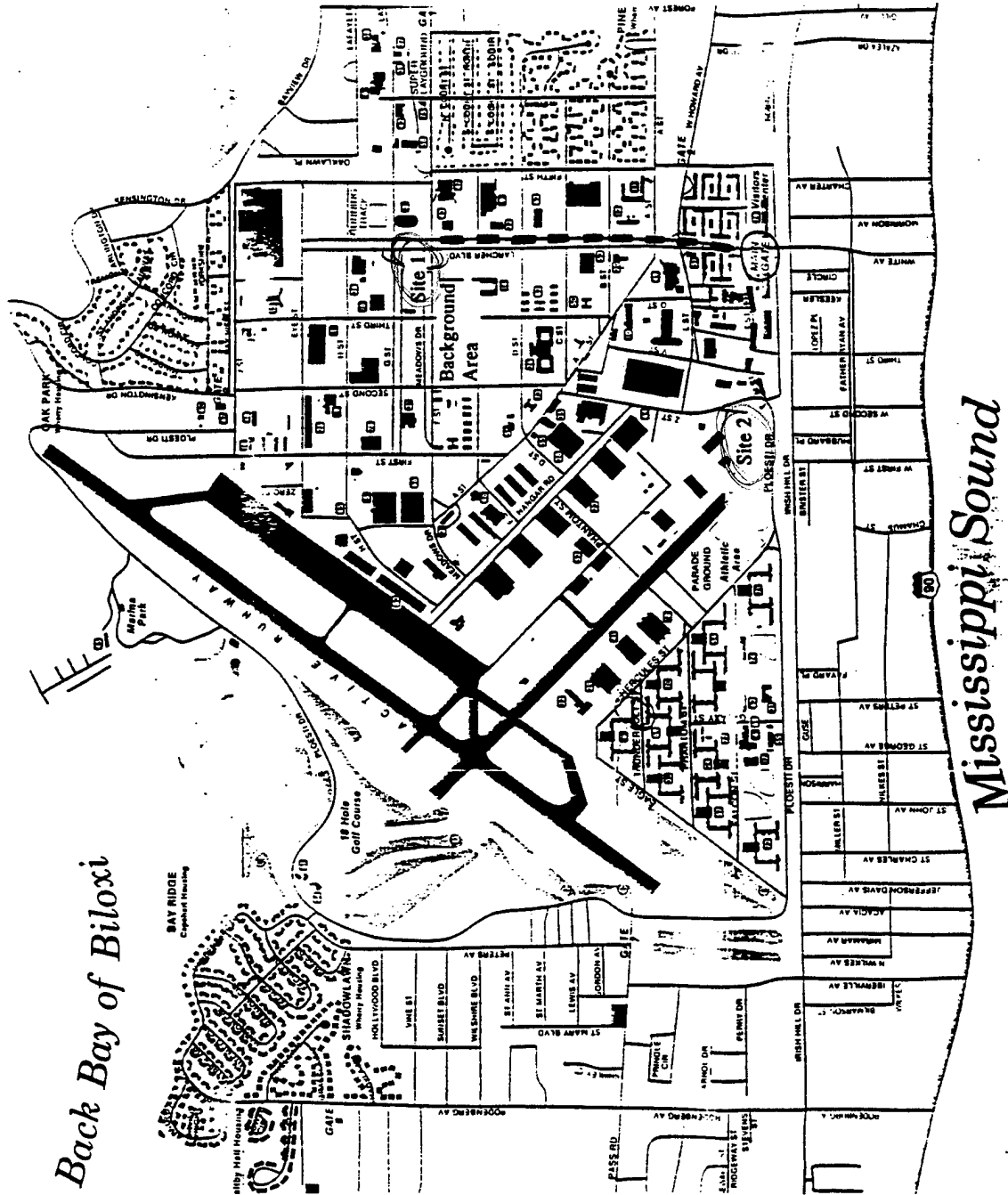
- The data from the soil gas permeability and in situ respiration tests will be used to determine an air injection/withdrawal rate for the bioventing test. A blower will be selected, installed, and operated for 6 to 12 months, and periodic measurements of the soil gas composition will be made to evaluate the long-term effectiveness of bioventing.

## 1.2 Site Description

Keesler AFB is located in Biloxi, Mississippi. A map of the base showing the locations of each site and the background area is shown in Figure 1. The dashed line on the map illustrates the direction from the main gate to each test site. Summaries of the descriptions of each site used for the Bioventing Initiative are presented in the following sections. A more detailed description of each test site is given in the Test Plan provided in Appendix A.

### 1.2.1 Area of Concern A (AOC A) (Site 1)

The BX Service Station is an active service station and is located at Larcher Boulevard and Meadows Drive, near Building 1504. A schematic diagram of the site, known as Area of Concern A, is shown in Figure 2. In 1987, 10 underground storage tanks (USTs) were removed from the BX Service Station. During the excavation, gasoline leaks were suspected based upon physical evidence and high vapor readings. Silty fine to medium sand was the most frequently reported material encountered in the subsurface between 0 to 15 ft. Groundwater is typically encountered at approximately 7 feet with groundwater flow toward the northeast. Analytical results from soil samples collected in 1992 indicated elevated levels of gasoline (up to 17,000 mg/kg). High concentrations of benzene (up to 1.6 mg/kg), ethylbenzene (up to 5.6 mg/kg), toluene (up to 760 mg/kg), and total xylenes (up to 790 mg/kg) were also found in some soil samples. Elevated levels of benzene, ethylbenzene, toluene, and total xylenes were detected in four monitoring wells at the site. An upgradient well (MW8-1) did not contain any of these compounds.



Site 1 = Area of Concern A  
 Site 2 = SWMU 66

Figure 1. Schematic Diagram of Keesler Air Force Base, Mississippi

- Injection Well
- Extraction Well
- Monitoring Point
- Building Monitoring Points
- ⊗ Monitoring Well

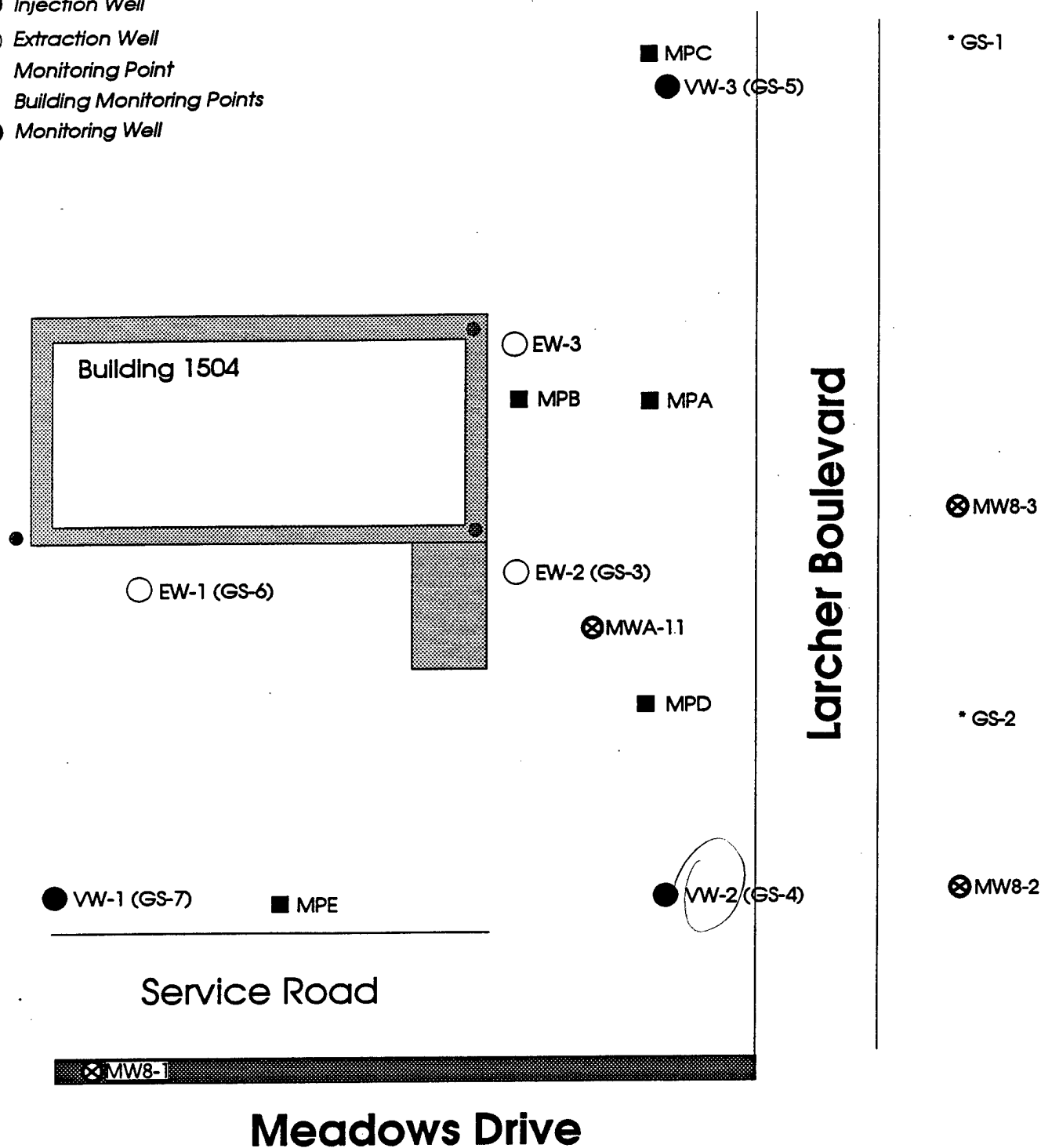


Figure 2. Schematic Diagram of Area of Concern A (GS - Soil Gas Survey Point; MP - Monitoring Point; IW - Injection Well; EW - Extraction Well) (not to scale)

### 1.2.2 Solid Waste Management Unit 66 (SWMU 66) (Site 2)

This site contains an abandoned UST site and three USTs that are still in service located approximately 60 feet northeast of Building 4038. A schematic diagram of the site is shown in Figure 3. The UST was removed in 1987. The USTs were used to store diesel and unleaded gasoline. The active USTs are not part of the investigations. The soils at this site are characterized as loamy sands which are well drained and permeable. Groundwater is reported to be shallow at the site. Soil samples taken in 1992 show elevated levels of TPH with concentrations as high as 19,000 mg/kg. Elevated levels of benzene (up to 46 mg/kg), toluene (up to 50 mg/kg), ethylbenzene (up to 420 mg/kg), and total xylenes (up to 370 mg/kg) were also found in soil samples. ✓

## 2.0 AREA OF CONCERN A

### 2.1 Chronology of Events and Site Activities

#### 2.1.1 Groundwater Measurements

Groundwater monitoring wells were present at AOC A. Groundwater was measured at the four existing monitoring wells. Groundwater was measured at 6.8 feet (MW8-1), 8.0 feet (MW8-2), 8.2 feet (MW8-3), and 8.25 feet (MWA-11). No product was detected at any of the monitoring wells.

#### 2.1.2 Soil Gas Survey

A suitable site for the bioventing demonstration should have soil gas characteristics of high TPH, low oxygen, and high carbon dioxide concentrations. This composition of soil gas would indicate that oxygen-limiting conditions for microbial activity are present and that the introduction of air may enhance biodegradation of TPH.

On April 20, 1993, a limited soil gas survey was conducted at AOC A. Soil gases were sampled by driving a 5/8-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH.

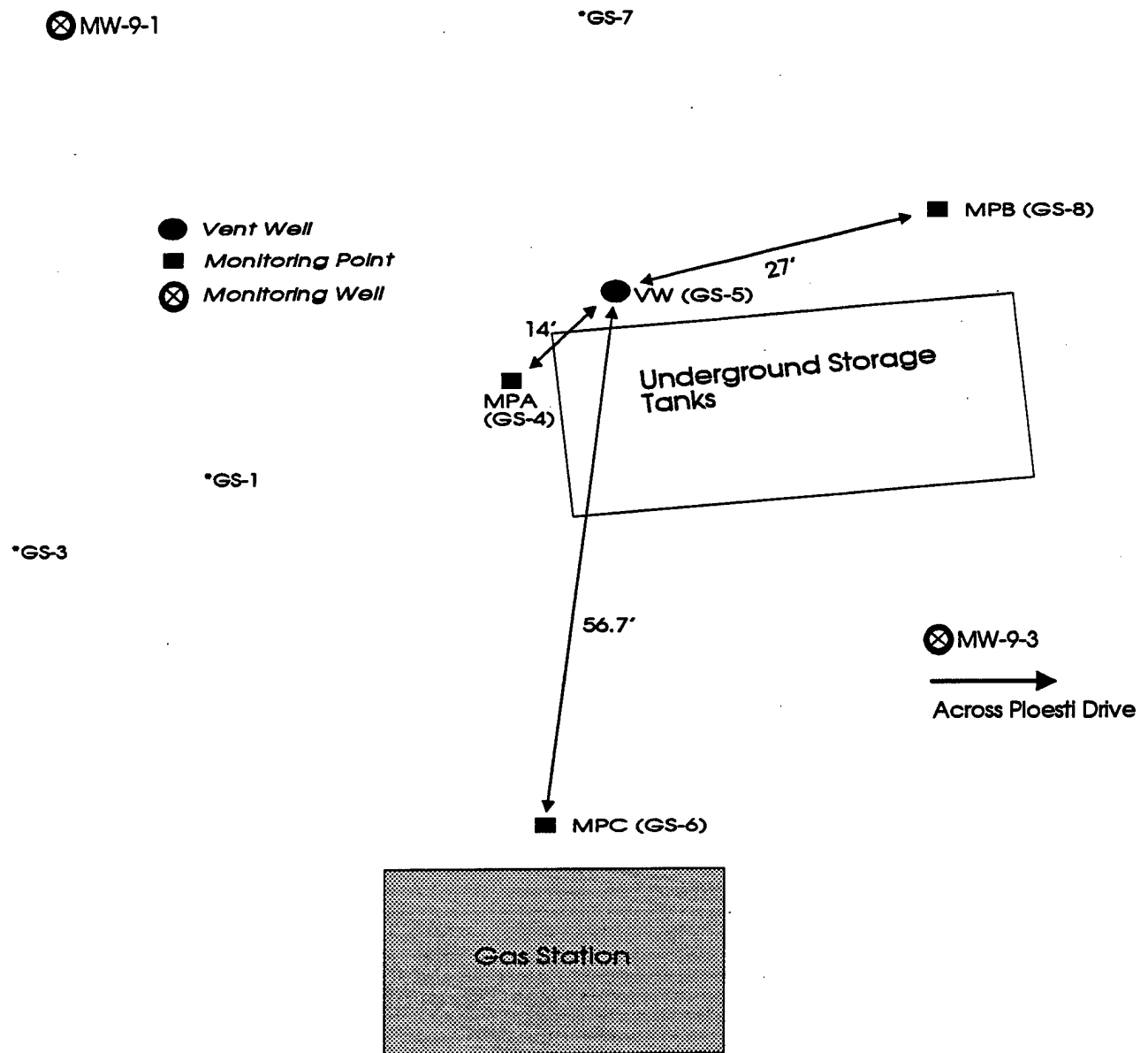


Figure 3. Schematic Diagram of SWMU 66 (GS - Soil Gas Survey Point; MP - Monitoring Point) (not to scale)

Measurements of oxygen and carbon dioxide in the soil gas were made with a GasTech Model 32520X with oxygen and carbon dioxide ranges of 0 to 25%. The analyzer was calibrated daily against atmospheric oxygen, atmospheric carbon dioxide, a 10% oxygen calibration standard, and a 5% carbon dioxide calibration standard. TPH was measured with a GasTech Trace Techtor with TPH ranges from 0 to 100, 0 to 1,000, and 0 to 10,000 ppm. The GasTech Trace Techtor was calibrated daily against a 4,200-ppm hexane standard.

The soil gas probes were driven to depths ranging from 2.5 to 7.0 feet at several locations in the area. In addition, soil gas concentrations at existing monitoring points were monitored. Table 1 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations. Oxygen concentrations varied from 0 to 3.0%, and TPH concentrations ranged from 16,000 to greater than 100,000 ppm. These results indicate that this site is oxygen-limited and may respond to bioventing. The oxygen results for GS-1 and GS-2 indicate that there is no oxygen limit in the grass median between northbound and southbound Larcher Boulevard.

### **2.1.3 Vent Well, Monitoring Point, and Thermocouple Installation**

On April 21 and 22, 1993, six vent wells (three extraction wells and three injection wells) and one monitoring point were installed at AOC A, and soil samples were collected for analyses. There were four existing monitoring points. The extraction wells (EW) were labeled K1-EW1, K1-EW2, and K1-EW3. The injection wells (IW) were labeled K1-IW1, K1-IW2, and K1-IW3. The monitoring point (MP) was labeled K1-MPE. The existing monitoring points were labeled K1-MPA, K1-MPB, K1-MPC, and K1-MPD. The locations of the vent wells and monitoring points are shown in Figure 2. A cross section of the vent wells and monitoring points showing site lithology and construction detail is shown in Figure 4.

The extraction and injection wells consisted of Schedule 40 2-inch-diameter polyvinyl chloride (PVC) piping with ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, and the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface. The extraction and injection wells were installed at depths as follows:

- Extraction well K1-EW1 was installed at a depth of 5.5 feet into a 6-inch-diameter borehole. The vent well was screened from 2.5 to 5.5 feet.

Table 1. Initial Soil Gas Composition at AOC A

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
K1-MPA	3.0	0	9.0	> 100,000
	5.0	0	9.5	> 100,000
	7.0	0	9.0	> 100,000
K1-MPB	2.5	0	10.0	> 100,000
	4.0	0	10.0	> 100,000
	7.0	0	9.7	> 100,000
K1-MPC	3.0	0.9	9.0	24,000
	5.0	0.8	9.5	24,000
	7.0	0.5	9.2	20,000
K1-MPD	3.0	0.5	9.8	16,000
	5.0	0	9.8	20,000
	7.0	0	9.5	22,000
GS-1	4.2	19.0	2.5	560
	7.0	19.0	2.5	600
GS-2	5.0	15.5	5.5	460
	7.5	16.0	5.0	1,000
GS-3	2.5	3.0	9.2	65,000
GS-4	4.0	1.0	9.8	30,000
GS-5	4.0	0.9	9.8	97,000
GS-6	4.5	2.5	6.0	60,000
GS-7	4.5	1.0	9.0	34,000

not O<sub>2</sub> limited

high

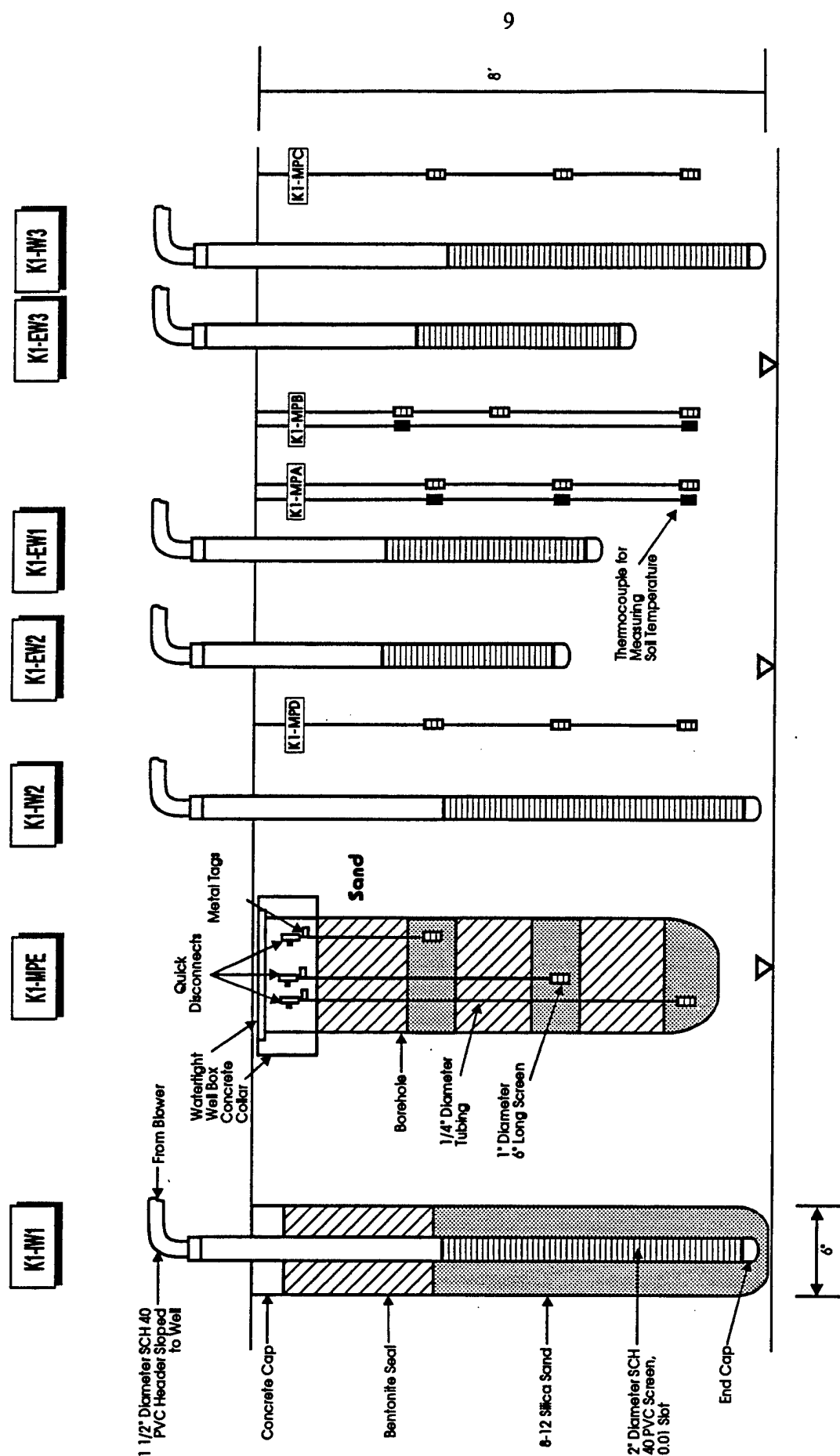


Figure 4. Cross Section of Vent Wells and Monitoring Points at AOC A Showing Site Lithology and Construction Detail (not to scale)

- Extraction well K1-EW2 was installed at a depth of 5.0 feet into a 6-inch-diameter borehole. The vent well was screened from 2.5 to 5.0 feet.
- Extraction well K1-EW3 was installed at a depth of 6.0 feet into a 6-inch-diameter borehole. The vent well was screened from 3.0 to 6.0 feet.
- Injection wells K1-IW1, K1-IW2, and K1-IW3 were installed at a depth of 8.0 feet into a 6-inch-diameter borehole. The vent wells were screened from 5.0 to 8.0 feet.

Soil gas probes consisted of ¼-inch tubing with a 1-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand, whereas the interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were installed at depths as follows:

- Monitoring point K1-MPA was installed at a depth of 7.0 feet into a 6-inch diameter borehole. The monitoring point was screened to three depths: 3.0, 5.0, and 7.0 feet.
- Monitoring point K1-MPB was installed at a depth of 7.0 feet into a 6-inch diameter borehole. The monitoring point was screened to three depths: 2.5, 4.0, and 7.0 feet.
- Monitoring point K1-MPC was installed at a depth of 7.0 feet into a 6-inch diameter borehole. The monitoring point was screened to three depths: 3.0, 5.0, and 7.0 feet.
- Monitoring point K1-MPD was installed at a depth of 7.0 feet into a 6-inch diameter borehole. The monitoring point was screened to three depths: 3.0, 5.0, and 7.1 feet.
- Monitoring point K1-MPE was installed at a depth of 7.0 feet into a 6-inch diameter borehole. The vent well was screened to three depths: 3.0, 5.0, and 7.0 feet.

Type J thermocouples were previously installed with the following monitoring points: K1-MPA-3.0', K1-MPA-5.0', K1-MPA-7.0', K1-MPB-3.0', and K1-MPB-7.0'.

#### 2.1.4 Soil and Soil Gas Sampling and Analyses

A soil sample was collected from injection well K1-IW1 at a depth of 6.5 to 7.0 feet and was labeled K-IW-1-6.5'-7.0'. A soil sample was collected from injection well K1-IW3 at a depth of 5.5

to 6.0 feet and was labelled K-IW-3-5.5'-6.0'. A soil sample was collected from extraction well K1-EW1 at a depth of 5.0 to 5.5 feet and was labeled K-EW-1-5.0'-5.5'. A soil sample was collected from extraction well K1-EW3 at a depth of 5.5 to 6.0 feet and was labeled K-EW-3-5.5'-6.0'. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of benzene, toluene, ethylbenzene, and xylenes (BTEX); TPH; alkalinity; moisture content; pH; iron; total phosphorous; total Kjeldahl nitrogen; and particle size.

Soil gas samples were collected from monitoring points K1-MPA at 3.0 and 7.0 feet, K1-MPB at 4.0 and 7.0 feet, and K1-MPC at 3.0 and 7.0 feet and were labeled K-MPA-3.0', K-MPA-7.0', K-MPB-4.0', K-MPB-7.0', K-MPC-3.0' and K-MPC-7.0'. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

#### **2.1.5 Soil Gas Permeability and Radius of Influence**

A detailed description of the method for conducting a soil gas permeability test, including equations to compute  $k$ , the soil gas permeability, is given in the Test Plan and Technical Protocol (Hinchee et al., 1992).

At AOC A, air was injected with a portable 1-horsepower (HP) explosion-proof positive displacement blower unit. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. Because the pressure measured at the monitoring points reached steady-state rapidly, the steady-state method for determining soil gas permeability was used.

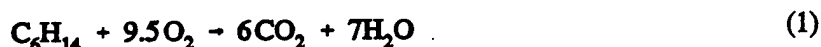
#### **2.1.6 In Situ Respiration Test**

Air containing approximately 1% helium was injected into the soil at AOC A for approximately 24 hours, beginning on April 25, 1993. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test is described by the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a 1/2-HP diaphragm pump. Air and helium were injected through the following monitoring points at the depths indicated: K1-MPA-5.0', K1-MPA-

7.0', K1-MPB-5.0' and K1-MPC-7.0'. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on April 26, 1993.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributed to either diffusion or leakage. A rapid drop in helium concentration followed by a leveling is an indication of leakage. A gradual loss along with an apparent first-order curve is an indicator of diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium gas diffuses about 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations are at least 50 to 60% of the initial levels at test completion, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

To compare data from one site to another, a stoichiometric relationship of the oxidation of the hydrocarbon was assumed. Hexane was used as the representative hydrocarbon for the organic contaminant. The stoichiometric relationship is given by:



Based on the utilization rates (% per day), the biodegradation rates in terms of mg as a hexane equivalent per kg of soil per day were computed using the equation below by assuming a soil porosity of 0.3 and a bulk density of 1,440 kg/m<sup>3</sup>.

$$K_b = \frac{-K_o A D_o C}{100} \quad (2)$$

- where:  $K_b$  = biodegradation rate (mg/kg/day)
- $K_o$  = oxygen utilization rate (percent per day)
- $A$  = volume of air/kg of soil, in this case  $300/1,440 = 0.21$
- $D_o$  = density of oxygen gas (mg/L), assumed to be 1,330 mg/L

C = mass ratio of hydrocarbon to oxygen required for mineralization, assumed to be 1/3.5 from the above stoichiometric equation.

## 2.2 Results and Discussion

### 2.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at AOC A are presented in Table 2. The analytical report for this site is presented in Appendix B. Concentrations of the BTEX compounds in soil samples ranged from below the detection limit for all compounds up to 0.85 mg/kg (ethylbenzene), and TPH concentrations ranged from less than 4.0 mg/kg up to 247 mg/kg. The soil gas analyses showed concentrations of the BTEX compounds ranging from less than 1.0 ppmv (benzene and toluene) up to 1,800 ppmv (benzene), whereas concentrations of TPH ranged from 21,000 to 200,000 ppmv (Table 2). The results of the soil chemistry analyses are summarized in Table 3.

### 2.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at AOC A are presented in Appendix C. Using the steady-state method for calculating soil gas permeability, a soil gas permeability of 21 darcys was determined.

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well. The radius of influence would then be the distance where 0.1 inch of water pressure can be measured. Therefore, the radius of influence based on these specifications is approximately 87 feet (Figure 5).

### 2.2.3 In Situ Respiration Test

The results of the in situ respiration test for AOC A are presented in Appendix D. Each figure in Appendix D illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 6, where oxygen utilization and carbon dioxide production at monitoring point K1-MPA-5.0' are illustrated. A

Table 2. Results From Soil and Soil Gas Analyses for BTEX and TPH at AOC A

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH <sup>1</sup> (mg/kg)
Soil	K1-IW-1-6.5'-7.0'	0.39	0.11	0.85	0.21	36
	K1-IW-3-5.5'-6.0'	<0.0033	0.012	0.0037	0.059	64
	K1-EW-3-5.5'-6.0'	<0.039	<0.059	<0.040	<0.102	247
	K1-EW-1-5.0'-5.5'	0.0048	0.0029	0.00063	0.0019	<4.0
Matrix	Sample Name	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Total Xylenes (ppmv)	TPH <sup>2</sup> (ppmv)
Soil Gas	K1-MPA-3.0'	1,800	1,000	56	150	190,000
	K1-MPA-7.0'	1,400	1,000	45	130	160,000
	K1-MPB-4.0'	1,700	590	140	310	200,000
	K1-MPB-7.0'	1,500	690	61	150	200,000
	K1-MPC-3.0'	<1.0	<1.0	1.8	1.0	21,000
	K1-MPC-7.0'	<2.0	<2.0	2.3	<2.0	25,000

<sup>1</sup> Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

<sup>2</sup> TPH referenced to jet fuel (molecular weight = 156).

Table 3. Results From Soil Chemistry Analyses at AOC A

Parameter	Sample Name			
	K1-IW-1-6.0'-6.5'	K1-IW-3-4.5'-5.0'	K1-EW-3-5.0'-5.5'	K1-EW-1-4.0'-5.0'
Alkalinity (mg/kg CaCO <sub>3</sub> )	67	610	270	46
Moisture (% by weight)	6.6	9.4	10.8	6.8
pH	6.2	7.7	7.5	6.6
Iron (mg/kg)	666	2,650	3,500	1,580
Total Phosphorous (mg/kg)	28	25	61	27
Total Kjeldahl Nitrogen (mg/kg)	54	31	76	<20
Particle Size (%)	Gravel: 0	Gravel: 0	Gravel: 0	Gravel: 0
	Sand: 87.5	Sand: 81.0	Sand: 88.6	Sand: 92.3
	Silt: 2.0	Silt: 12.8	Silt: 2.4	Silt: 3.0
	Clay: 10.6	Clay: 6.2	Clay: 9.1	Clay: 4.7

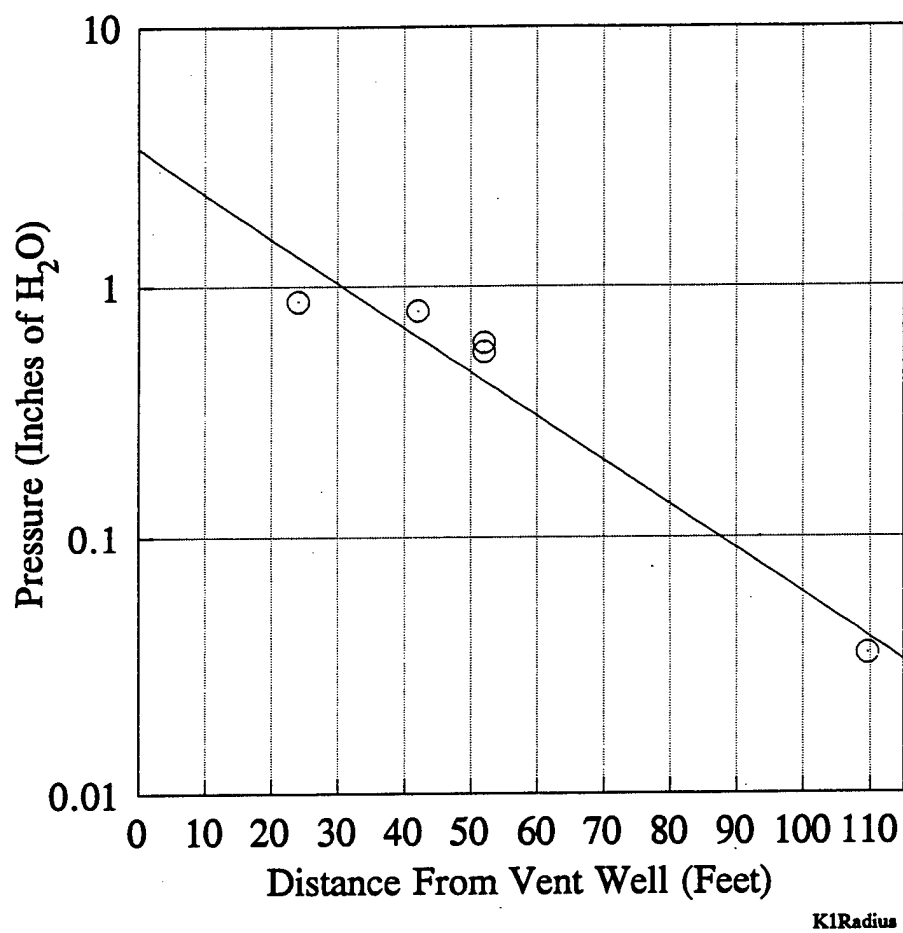


Figure 5. Radius of Influence at AOC A

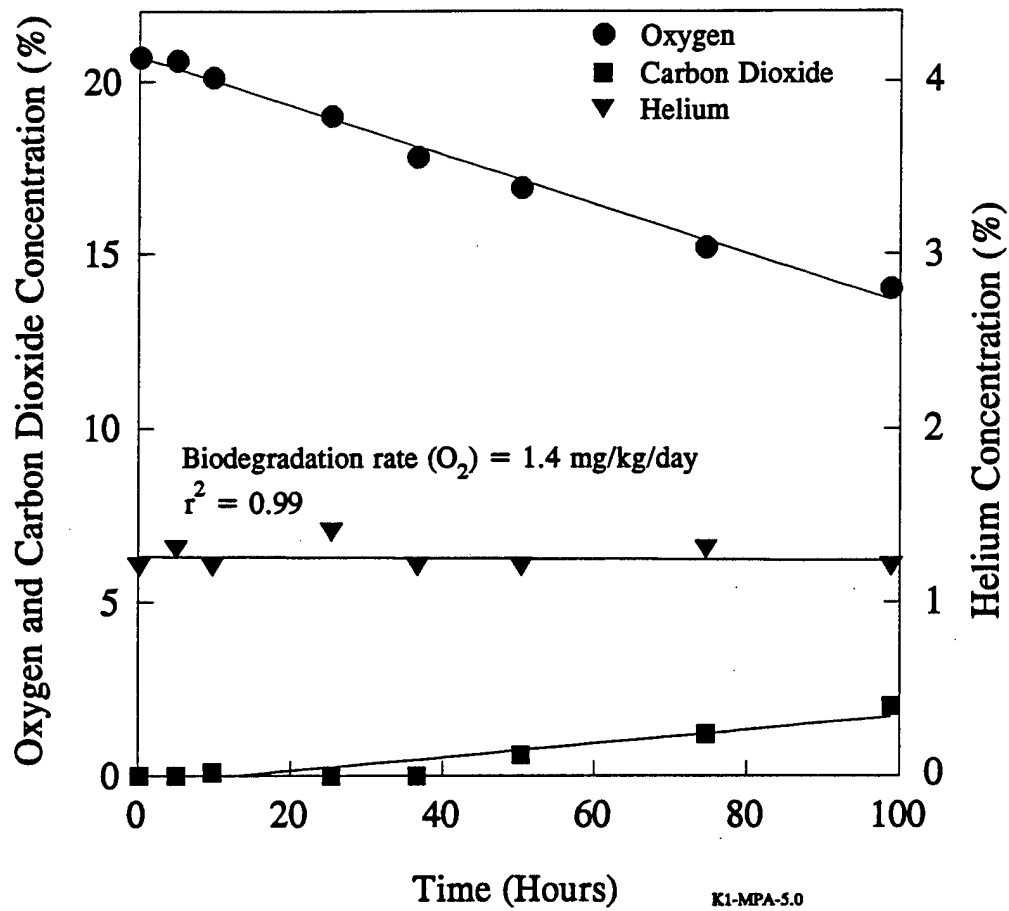


Figure 6. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K1-MPA-5.0' at AOC A

summary of the oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates is shown in Table 4. The biodegradation rates measured at this site ranged from 0.86 to 2.9 mg/kg/day based on oxygen utilization, and from 0.20 to 0.90 mg/kg/day based on carbon dioxide production.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 22°C to 25.8°C.

#### 2.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at AOC A. The blower operation was initiated on May 12, 1993 at a flowrate of 21 cfm and a pressure of 10 inches of water.

**Table 4. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at AOC A**

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.011	0.24 <i>0.21</i>	0.0093	0.20
K1-MPA-5.0'	0.065	1.4 <i>1.24</i>	0.020	0.43
K1-MPA-7.0'	0.040	0.86 <i>0.77</i>	0.014	0.29
K1-MPB-5.0'	0.13	2.9 <i>2.49</i>	0.034	0.73
K1-MPC-7.0'	0.088	1.9 <i>1.69</i>	0.042	0.90

### 3.0 SOLID WASTE MANAGEMENT UNIT 66

#### 3.1 Chronology of Events and Site Activities

##### 3.1.1 Groundwater Measurements

Groundwater monitoring wells were present at SWMU 66. Groundwater was measured at the two existing monitoring wells. Groundwater was measured at 4.46 feet (MW-9-1) and at 4.55 feet (MW-9-3). No product was detected at any of the monitoring wells.

##### 3.1.2 Soil Gas Survey

On April 16, 1993, a limited soil gas survey was conducted to locate a suitable test area at SWMU 66. Soil gases were sampled by driving a  $\frac{5}{8}$ -inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH. Soil gas measurements were taken as described in Section 2.1.2.

The soil gas probes were driven to a depth of 2.5 feet at several locations at SWMU 66. Table 5 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations. Relatively low concentrations of oxygen were found at some of the soil gas probes, with concentrations ranging from 0.0 to 16.5%. Relatively high concentrations of carbon dioxide (5.8 to 11.5%) and TPH (50,000 to greater than 100,000 ppm) were encountered. The low concentrations of oxygen indicate that some areas at this site may respond to bioventing.

##### 3.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On April 17, 1993, one vent well and three monitoring points were installed at SWMU 66 and soil samples were collected for analyses. The monitoring points were labeled K2-MPA, K2-MPB, and K2-MPC. The locations of the vent well and monitoring points are shown in Figure 3. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 7.

The vent well was installed at a depth of 7.75 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 4.5 feet of ten-slot screen. The

Table 5. Initial Soil Gas Composition at SWMU 66

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	16.5 <sup>1</sup>	6.0	50,000
GS-2	2.5	0	11.5	> 100,000
GS-4	2.5	0	11.0	> 100,000
GS-5	2.5	0	10.8	> 100,000
GS-6	2.5	15.5 <sup>1</sup>	5.8	90,000
GS-8	2.5	7.2 <sup>1</sup>	10.0	> 100,000

<sup>1</sup> Pressure reading on sampling pump was high. Measured oxygen concentration may not be representative of actual soil gas oxygen concentrations. Actual oxygen concentration is likely to be lower.

K2-MPC

K2-MPA

VENT WELL

K2-MPB

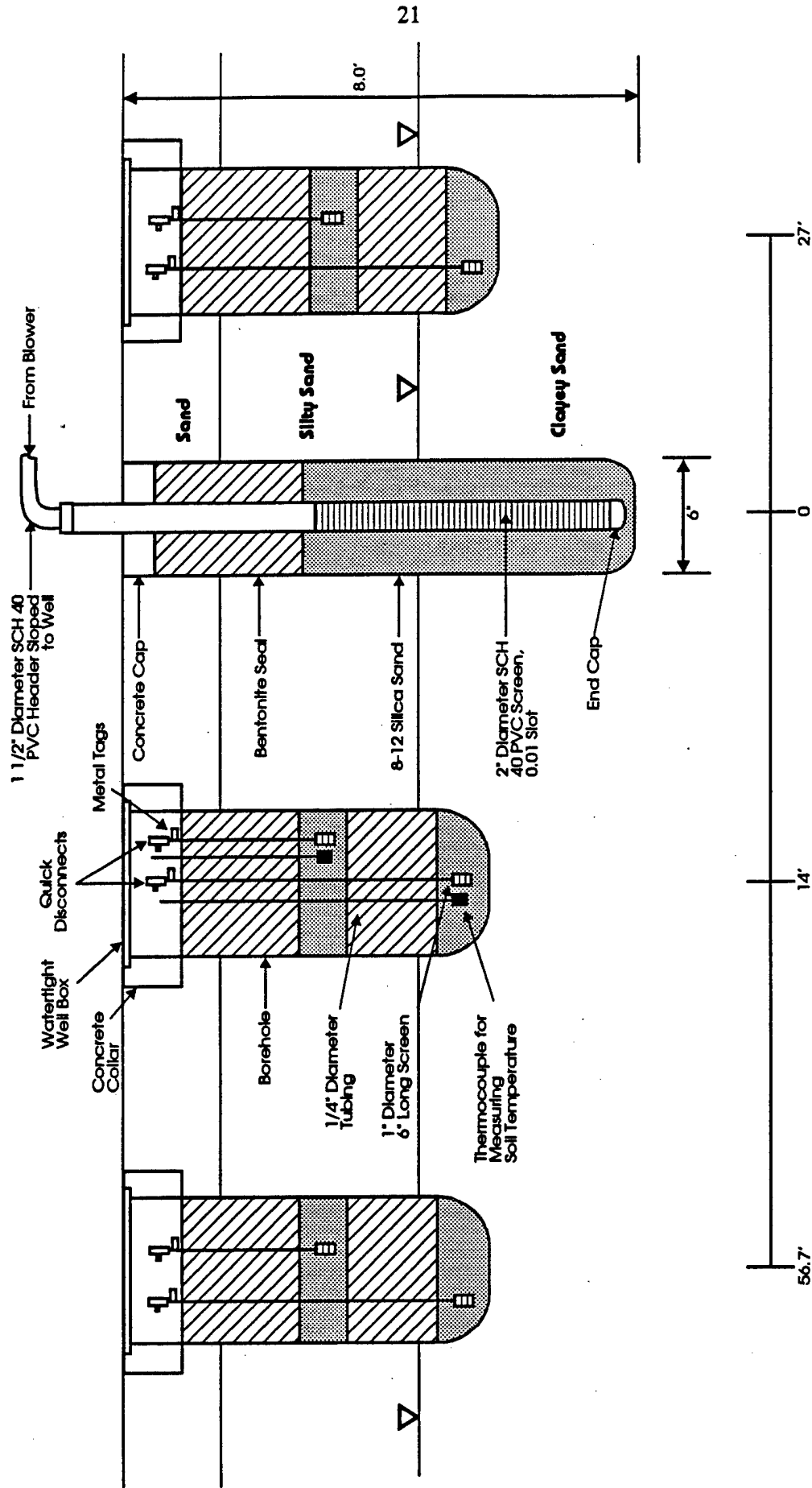


Figure 7. Cross Section of the Vent Well and Monitoring Points at SWMU 66 Showing Site Lithology and Construction Detail (not to scale)

annular space corresponding to the screened area of the well was filled with silica sand, whereas the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes consisted of ¼-inch tubing with a 1-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand, whereas the interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were installed at depths as follows:

- Monitoring point K2-MPA was installed at a depth of 5.7 feet into a 6-inch diameter borehole. The monitoring point was screened to two depths: 3.0 and 5.5 feet.
- Monitoring point K2-MPB was installed at a depth of 5.9 feet into a 6-inch diameter borehole. The monitoring point was screened to two depths: 3.0 and 5.5 feet.
- Monitoring point K2-MPC was installed at a depth of 5.7 feet into a 6-inch diameter borehole. The monitoring point was screened to two depths: 3.5 and 5.7 feet.

Type J thermocouples were installed with monitoring points K2-MPA-3.0' and K2-MPA-5.5'.

#### 3.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples were collected from monitoring points K2-MPA and K2-MPC at a depth of 3.0 to 3.5 feet, and were labeled K1-MPA-3.0'-3.5' and K1-MPC-3.0'-3.5', respectively. A soil sample was also collected from the vent well at a depth of 3.0 to 3.5 feet and was labeled K1-VWA-3.0'-3.5'. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX; TPH; alkalinity; moisture content; pH; iron; total phosphorous; total Kjeldahl nitrogen; and particle size.

Soil gas samples were collected from monitoring points K2-MPA at 3.0 feet and K2-MPB at 3.0 feet, and were labeled K1-MPA-3.0' and K1-MPB-3.0', respectively. A soil gas sample was collected from the vent well and was labeled K1-VW-3.0-8.0'. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

### 3.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute  $k$ , the soil gas permeability, is presented by the Test Plan and Technical Protocol (Hinchee et al., 1992).

A portable 1-HP explosion-proof positive displacement blower unit was used to inject air at SWMU 66. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The steady-state method was used to calculate the soil gas permeability.

### 3.1.6 In Situ Respiration Test

The setup for the in situ respiration test was as described in Section 2.1.6. Air containing approximately 1% helium was injected into the soil at SWMU 66 for approximately 24 hours, beginning on April 20, 1993. The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the vent well and at monitoring points, K2-MPA-3.0' and K2-MPB-3.0'. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on April 21, 1993.

## 3.2 Results and Discussion

### 3.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at SWMU 66 are presented in Table 6. The analytical report for this site is presented in Appendix B. Concentrations of the BTEX compounds in soil samples ranged from below the detection limit for all compounds up to 340 mg/kg (toluene), and TPH concentrations ranged from 31 mg/kg up to 8,400 mg/kg. The soil gas analyses showed concentrations of the BTEX compounds ranging from 0.065 ppmv (ethylbenzene) up to 130 ppmv (toluene), whereas concentrations of TPH ranged from 150 to 22,000 ppmv (Table 6). The results of the soil chemistry analyses are summarized in Table 7.

Table 6. Results From Soil and Soil Gas Analyses for BTEX and TPH at SWMU 66

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH <sup>1</sup> (mg/kg)
Soil	K1-MPA-3.0'-3.5'	10	12	<0.80	7.6	8,400
	K1-MPC-3.0'-3.5'	<0.00067	0.0022	<0.00053	<0.0019	31
	K1-VWA-3.0'-3.5'	<8.0	93	48	340	1,500
Matrix	Sample Name	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Total Xylenes (ppmv)	TPH <sup>2</sup> (ppmv)
Soil Gas	K2-MPA-3.0'	9.0	0.63	0.37	0.24	2,400
	K2-MPB-3.0'	3.3	0.23	0.065	0.30	150
	K1-VW-3.0-8.0'	56	130	13	59	22,000

<sup>1</sup> Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

<sup>2</sup> TPH referenced to jet fuel (molecular weight = 156).

Table 7. Results From Soil Chemistry Analyses at SWMU 66

Parameter	Sample Name		
	K1-MPA-3.0'-3.5'	K1-MPC-3.0'-3.5'	K1-VWA-3.0'-3.5'
Alkalinity (mg/kg $\text{CaCO}_3$ )	300	120	370
Moisture (% by weight)	10.2	12.0	12.3
pH	7.6	7.3	7.5
Iron (mg/kg)	11,100	1,260	674
Total Phosphorous (mg/kg)	200	220	150
Total Kjeldahl Nitrogen (mg/kg)	76	130	99
Particle Size Analysis (%)	Gravel: 0	Gravel: 0	Gravel: 0
	Sand: 77.0	Sand: 88.4	Sand: 87.9
	Silt: 7.3	Silt: 4.0	Silt: 7.4
	Clay: 15.7	Clay: 7.6	Clay: 4.7

### 3.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at SWMU 66 are presented in Appendix E. Using the steady-state method for calculating soil gas permeability, a soil gas permeability of 0.74 darcys was determined.

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well. The radius of influence would then be the distance where 0.1 inch of water pressure can be measured. Therefore, the radius of influence based on these specifications is approximately 55 feet (Figure 8).

### 3.2.3 In Situ Respiration Test

The results of the in situ respiration test for SWMU 66 are presented in Appendix F. Each figure in Appendix F illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. Biodegradation rates at SWMU 66 were relatively high with rates ranging from 7.5 to 27 mg/kg/day. An example of typical oxygen utilization at this site is shown in Figure 9, where oxygen utilization and carbon dioxide production at monitoring point K2-MPA-3.0' are illustrated. A summary of the oxygen utilization and carbon dioxide production rates and the corresponding biodegradation rates is shown in Table 8.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test and ranged from 22.6°C to 23.4°C.

### 3.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at SWMU 66. The bioventing system was initiated on May 12, 1993, at a flowrate of 5 standard cubic feet per minute (scfm) and 7 inches of water.

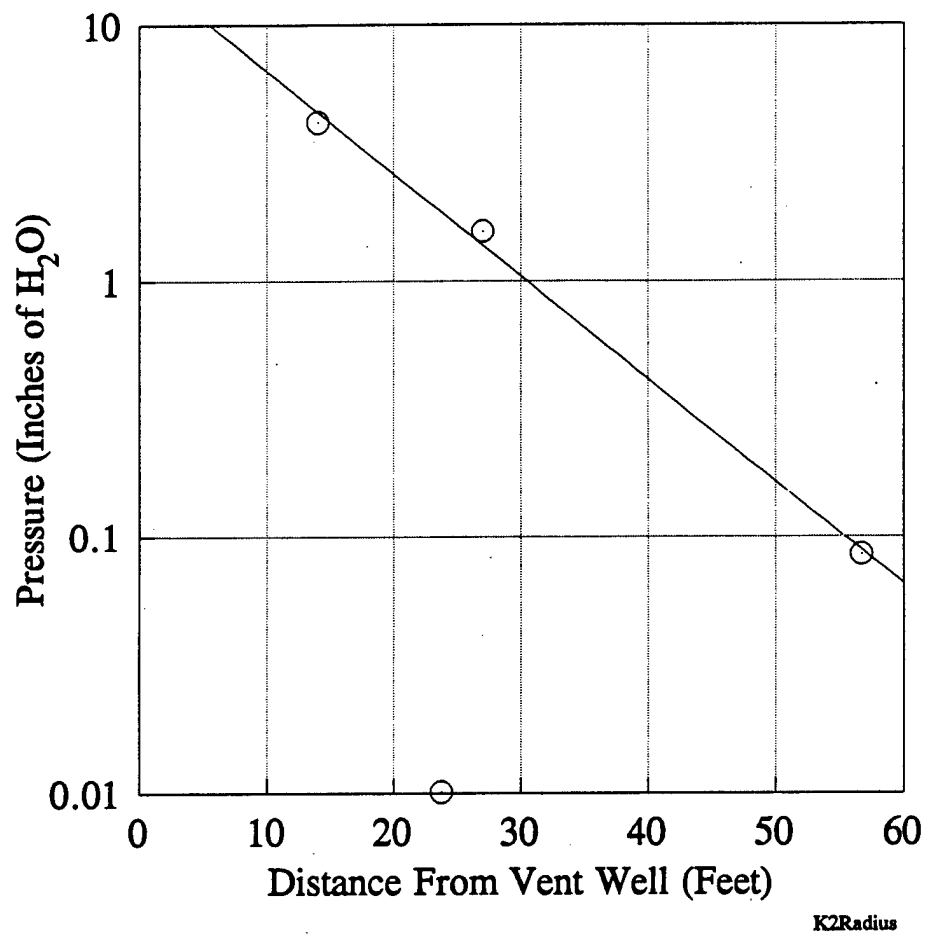


Figure 8. Radius of Influence at SWMU 66

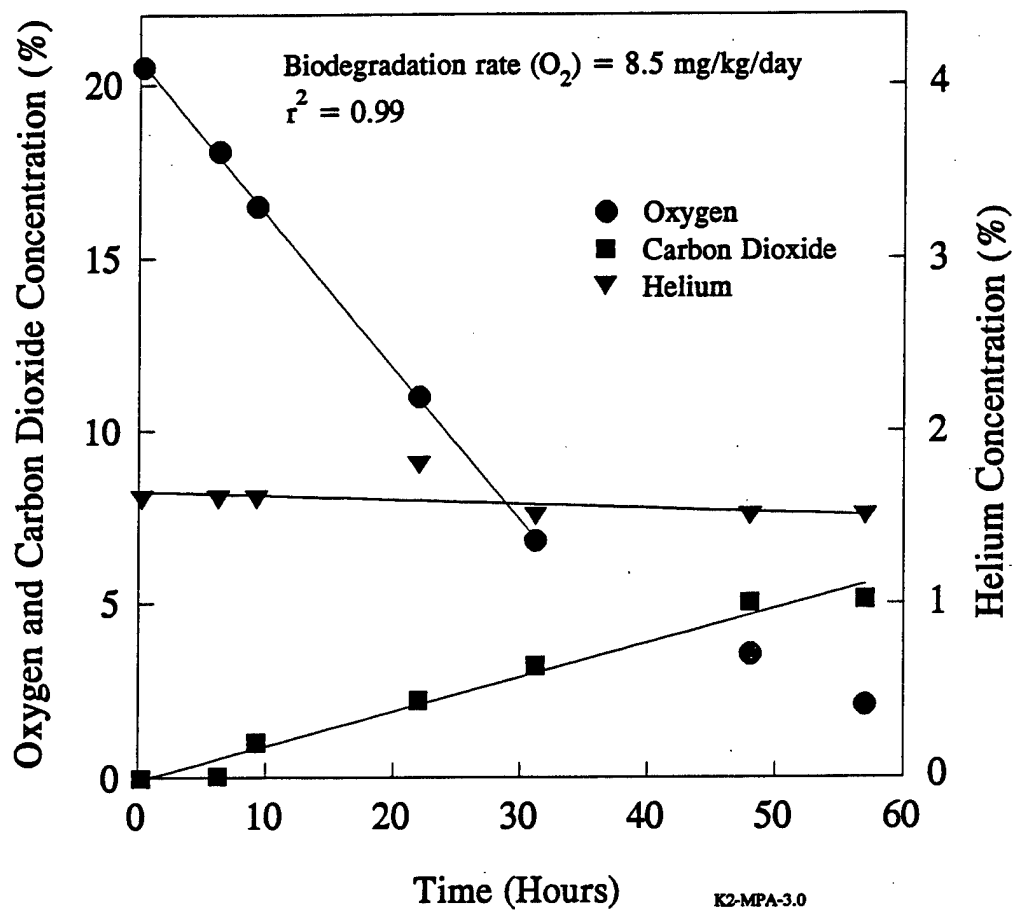


Figure 9. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K2-MPA-3.0' at SWMU 66

**Table 8. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at SWMU 66**

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.011	12% 0.24 21	0.0093	0.20
K2-MPA-3.0'	0.39	17% 8.5 7.6	0.099	2.1
K2-MPB-3.0'	0.35	10% 7.5 6.7	0.063	1.4
Vent Well	1.2	15% 27 23	0.021	3.9

#### 4.0 BACKGROUND AREA

An uncontaminated background area was located approximately 100 feet upgradient of AOC A (Figure 1). An existing monitoring well was used as the vent well in this area. The site lithology at this area was representative of that in the contaminated areas.

A soil sample was collected by hand auger at a depth of 4.5 to 5.0 feet and was labeled K-BG-4.5'-5.0'. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, total Kjeldahl nitrogen, and particle size. A soil gas sample was collected from the vent well and was labeled K-BKG. This sample was sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

Results of the soil analyses for BTEX and TPH are presented in Table 9. The analytical report for this site is presented in Appendix B. Both BTEX compounds and TPH were at concentrations below the detection limit in soil samples. The soil gas analyses also showed relatively low BTEX and TPH concentrations with concentrations ranging from below the detection limit for benzene, ethylbenzene, and total xylenes up to 0.0080 ppmv of toluene. The TPH concentration was 120 ppmv (Table 9). The results of the soil chemistry analyses are summarized in Table 10.

An in situ respiration test was conducted at the background area beginning on April 22, 1993, after 24 hours of air injection. The test was concluded on April 30. No significant change in oxygen concentration was observed at this area (Figure 10).

**Table 9. Results From Soil and Soil Gas Analyses for BTEX and TPH at the Background Area**

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH <sup>1</sup> (mg/kg)
Soil	K-BG-4.5'-5.0'	<0.00066	<0.00082	<0.00052	<0.0019	<4.0
Matrix	Sample Name	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Total Xylenes (ppmv)	TPH <sup>2</sup> (ppmv)
Soil Gas	K-BKG	<0.0080	0.0080	<0.0080	<0.0080	120

<sup>1</sup> Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

<sup>2</sup> TPH referenced to jet fuel (molecular weight = 156).

**Table 10. Results From Soil Chemistry Analyses at the Background Area**

Parameter	Sample Name
	K-BG-4.5'-5.0'
Alkalinity (mg/kg CaCO <sub>3</sub> )	84
Moisture (% by weight)	10.4
pH	7.5
Iron (mg/kg)	1,480
Total Phosphorous (mg/kg)	260
Total Kjeldahl Nitrogen (mg/kg)	69
Particle Size (%)	Gravel: 0
	Sand: 84.2
	Silt: 6.4
	Clay: 9.4

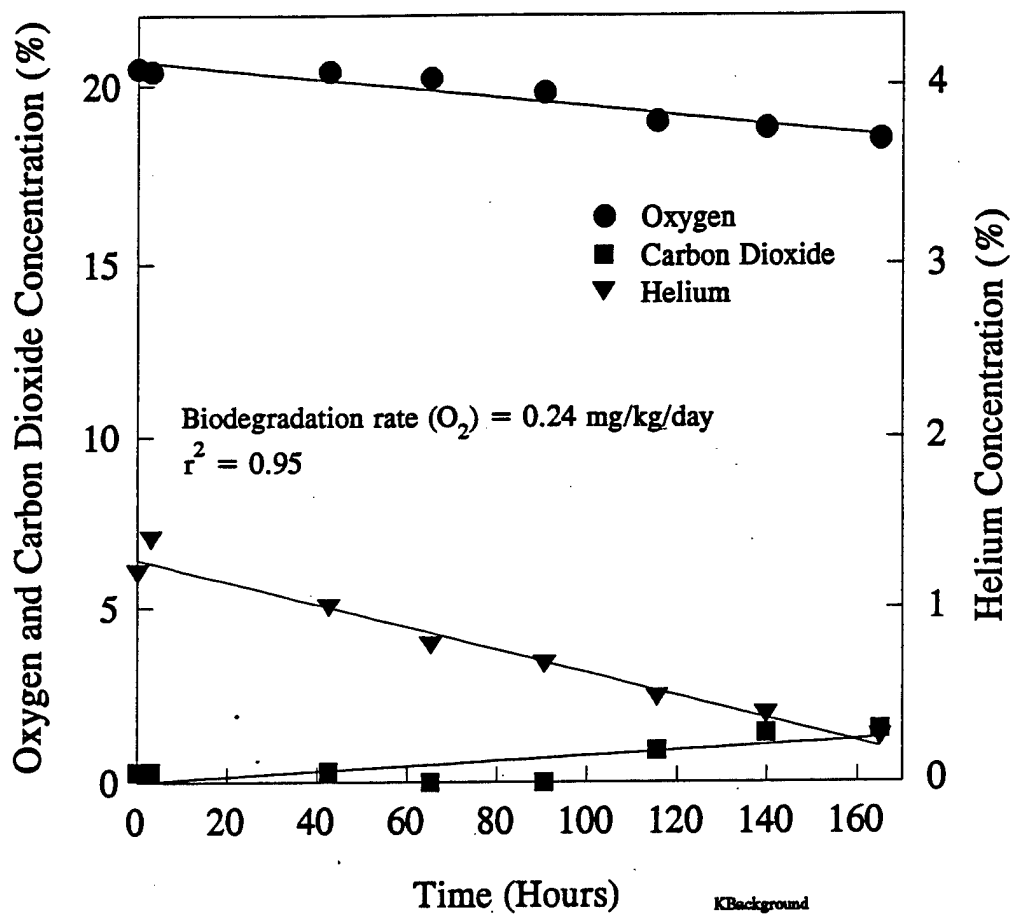


Figure 10. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at the Background Area

## 5.0 FUTURE WORK

Base personnel will be required to perform a simple weekly system check to ensure that the blower is operating within its intended flowrate, pressure, and temperature range. An on-site briefing for base personnel who will be responsible for blower system checks was conducted when the blowers were installed. The principle of operation was explained, and a simple checklist and logbook were provided for blower data. Base personnel will be asked to perform minor maintenance activities, such as replacing filters or gauges, or draining condensate from knockout chambers, but they will not be expected to perform complicated repairs or analyze gas samples. Replacement filters and gauges will be provided and shipped to the base, and serious problems, such as motor or blower failures, will be corrected by Battelle.

The progress of this system will be monitored by conducting semiannual respiration tests in the vent well and in each monitoring point and by regularly measuring the oxygen, carbon dioxide, and hydrocarbon concentrations in the extracted soil gas and comparing them to background levels. At least twice each year, the progress of the bioventing test will be reported to the base point-of-contact.

## 6.0 REFERENCE

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Rev. 2), Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering Sciences, Inc. for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

**APPENDIX A**  
**TEST PLAN FOR KEESLER AFB, MISSISSIPPI**



**Battelle**

*Putting Technology To Work*

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Columbus, Ohio 43201-2693  
Telephone (614) 424-6424  
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March 5, 1993

Captain Catherine Vogel  
Department of the Air Force  
AI/EQ  
139 Barnes Drive  
Tyndall AFB, Florida 32403-5319

Dear Cathy :

**SUBJECT: TEST PLAN FOR BIOVENTING INITIATIVE  
FIELD TEST AT KEESLER AIR FORCE BASE, MISSISSIPPI**

This letter was prepared to accompany the report "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing." The protocol document was developed as a generic test plan for the Air Force Bioventing Initiative Project in which Keesler AFB is participating. This letter outlines site specific information to support the generic test plan which is presented in Appendix B.

The three sites anticipated for the bioventing test initiative are Area of Concern A (AOC A), SWMU 64, and SWMU 66. The selection of these sites was based on site characterization data provided from studies conducted by Engineering-Science, Inc.

The purpose of this project is to investigate the feasibility of using the bioventing technology to remediate petroleum contaminated soils at the above mentioned facilities.

**Site Descriptions**

Keesler AFB is located in Biloxi, Mississippi. Site descriptions of the three sites proposed for this study are given below.

**Area of Concern A**

The BX Service Station is an active service station and is located at Larcher Boulevard and Meadows Drive, near Building 1504 (Figure 1). In 1987, 10 underground storage tanks (USTs) were removed from the BX Service Station. During the excavation, gasoline leaks were suspected based upon physical evidence and high vapor readings. Silty fine to medium sand was the most frequently reported material encountered in the subsurface between 0 to 15 ft (Figure

2). Groundwater is typically encountered at approximately 6 ft below ground surface with groundwater flow toward the northeast. Analytical results from soil samples collected in 1992 indicated elevated levels of gasoline (up to 17,000 mg/kg). High concentration of benzene (up to 1.6 mg/kg), ethylbenzene (up to 5.6 mg/kg), toluene (up to 760 mg/kg), and total xylenes (up to 790 mg/kg) were also found in some soil samples. Elevated levels of benzene, ethylbenzene, toluene, and total xylenes were detected in four monitoring wells at the site. An upgradient well (MW8-1) did not contain any of these compounds.

It is likely that the blower installed here would have to be configured for extraction of soil gas rather than for injection due to its proximity to the service station. Regulatory approval will be required prior to initiation of the long-term bioventing test if the blower is configured for withdraw.

#### SWMU 64

This site consists of 10 abandoned tank pits located in the southeastern portion of the base along Z street, west of Building 4002, and within 200 feet of the petroleum oil and lubricants area (Figure 3). The USTs were removed in 1987 and soil discoloration was observed at that time. Six of the tanks were used to store automotive gasoline, one was used to store kerosene, two were used to store diesel, and one was used to store mixed solvents. The subsurface at this site consists primarily of interbedded silty sand and peat (Figure 4). Groundwater is found at a depth of approximately 6 to 7 feet with the groundwater flow to the north. Soil samples taken immediately after removal of the USTs showed high concentration of TPH, with concentrations ranging from 137 to 622 mg/kg. Soil samples taken in 1992 show some areas that are still above 100 mg/kg, the regulatory level for the State of Mississippi.

#### SWMU 66

This site contains an abandoned UST site and three USTs that are still in service located approximately 60 feet northeast of Building 4038 (Figure 5). The UST was removed in 1987. The USTs were used to store diesel and unleaded gasoline. The active USTs are not part of the investigations. The soils at this site are characterized as loamy sands which are well drained and permeable. Groundwater is reported to be shallow at the site, but no soil boring logs were available for this test plan. Soil samples taken in 1992 show elevated levels of TPH with concentrations as high as 19,000 mg/kg. Elevated levels of benzene (up to 46 mg/kg), toluene (up to 50 mg/kg), ethylbenzene (up to 420 mg/kg), and total xylenes (up to 370 mg/kg) were also found in soil samples.

### Project Activities

The following field activities are planned for the bioventing project at Keesler AFB. The same procedures will be followed at each test site. Additional detail can be found in Section 5.0 of the generic Test Plan and Technical Protocol.

1. A small-scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. Soil vapor from the candidate site must exhibit high petroleum hydrocarbon concentrations (10,000 ppm or greater), relatively low oxygen concentrations (0 to 2.0%), and relatively high carbon dioxide concentrations (depending on soil type, 2.0 to 10.0%). An uncontaminated background location will also be identified.
2. Once the installation sites are located, one vent well and three 3-level soil gas monitoring points will be installed in the contaminated location and one vent well and one 3-level soil gas monitoring point will be installed in the background area. The wells and monitoring points will be installed using a drill rig to bore down to just above the water table. Three to four soil samples will be collected for chemical/physical analysis.
3. The air permeability test will be conducted in the contaminated test location.
4. Following the air permeability test, in situ respiration tests will be conducted in both the contaminated and the background test locations.
5. Depending on the results of the air permeability test and the in situ respiration test, a decision will be made whether or not to install a blower system in the contaminated area for the long term bioventing test. If the decision is made to install, the blower will be plumbed to the vent well and bioventing will be started (assuming power is available). Site personnel will be trained for blower operation prior to Battelle leaving the site.

### Schedule

Field activities at Keesler AFB are planned to begin on April 15, 1993. Battelle will have 2 to 3 people on site for approximately 3 weeks.

### Base Support

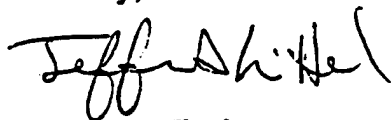
Keesler AFB needs to be able to provide the following:

Captain Catherine Vogel  
Department of the Air Force  
March 5, 1993  
Page 4

- Digging permits and utility clearance for all sites need to be obtained prior to the initiation of the field work. Underground utilities should be clearly marked to reduce the chance of utility damage or personal injury during soil gas probe and well installation. Battelle will not be able to begin field operations without these clearances.
- Electrical power will be need to be easily accessible from the project site. The air permeability test and in situ respiration test can be performed using a gasoline powered electric generator. The operation of the bioventing system will require a permanent 220/110 V power source. If power will not be available immediately after the test is completed, the bioventing system will be installed for start-up at a later date.
- Regulatory approval, if any is required, will need to be obtained by the base prior to start-up of the bioventing system. The bioventing system at AOC A is likely to require regulatory approval since it may be configured for extraction and there will be a point-source vapor emission. The other site are likely to be configured for air injection so there will be no point-source vapor emission from the system. The wells to be installed will not intersect the apparent water table and no groundwater will be pumped.
- Drums for containment of contaminated soil cuttings. The base will be responsible for disposal of any contaminated soils.
- Base and site clearance will be required for Battelle's site employees. We will furnish the base point-of-contact with personal information for each person at least one week prior to starting field operations.

Thank you for your support for this bioremediation research project. If you have any questions please feel free to call me at (614) 424-6122.

Sincerely,



Jeffrey A. Kittel  
Environmental Technology Department

JAK:sh

Attachments

cc: Major Ross Miller (AFCEE)  
Ruth Fruland (EMO) ✓  
Margaret Sartor, IRP Manager  
Captain Young (Keesler AFB)

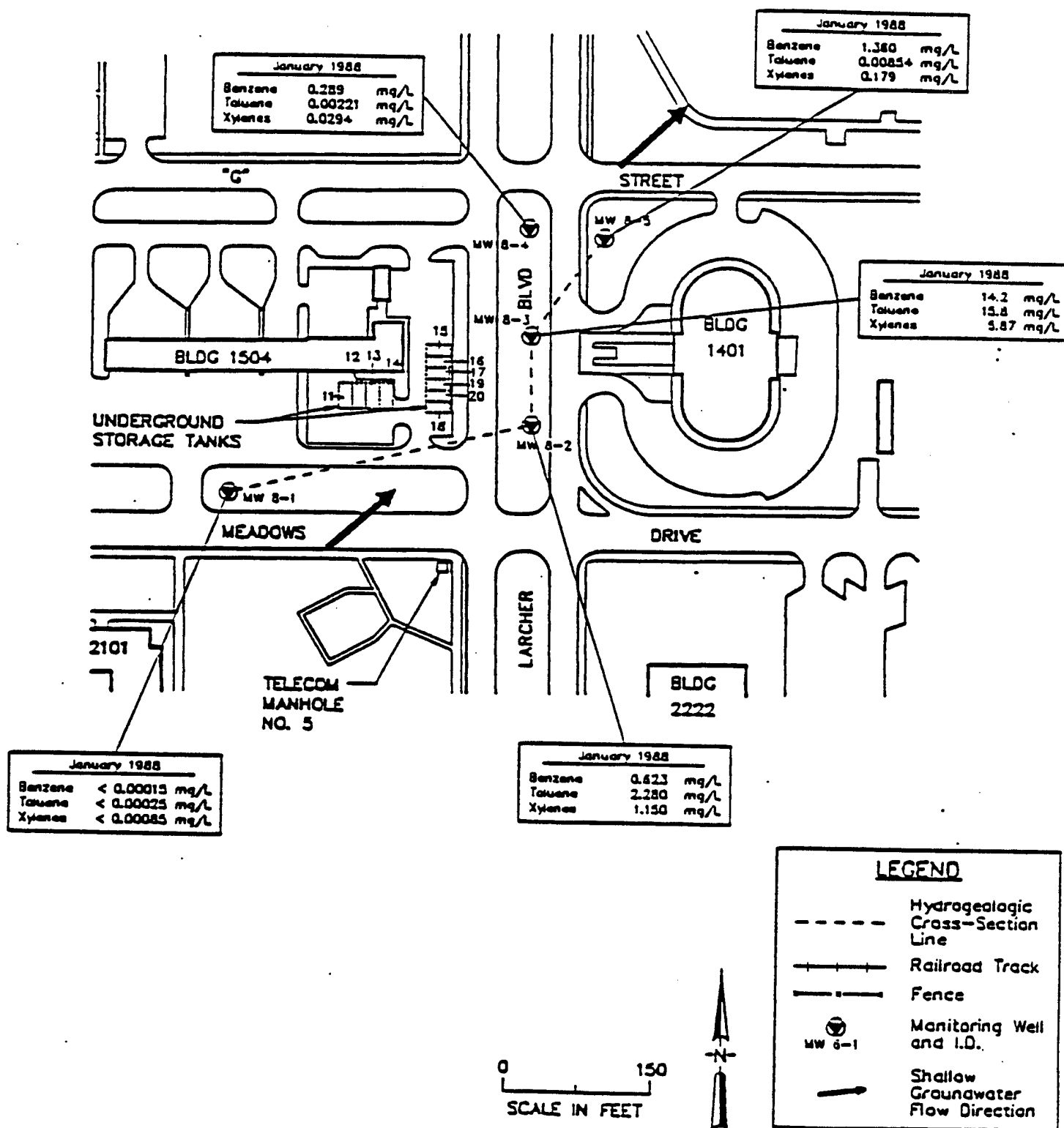


Figure 1. Schematic Diagram of AOC A

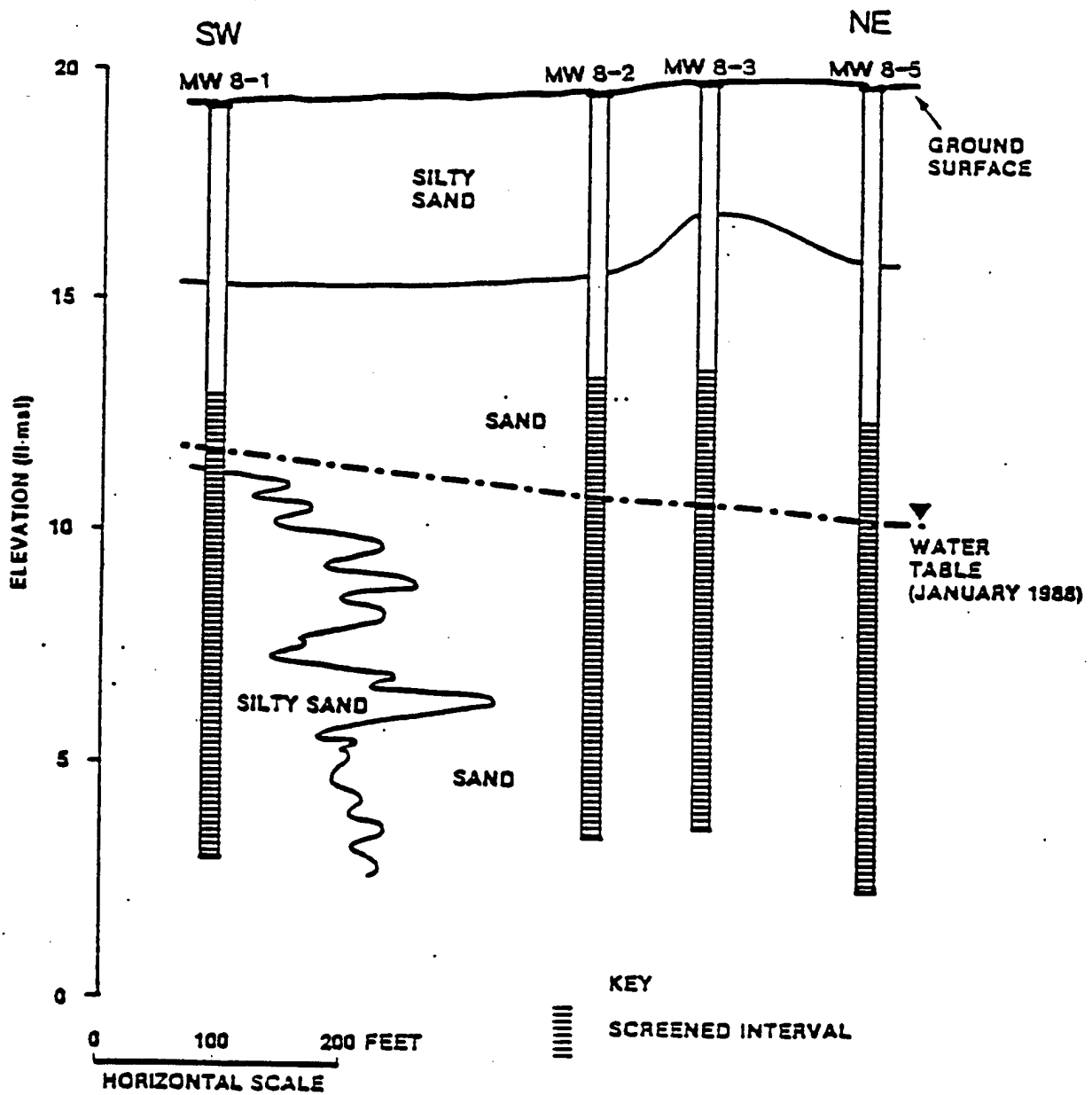


Figure 2. Hydrogeologic Cross Section of AOC A

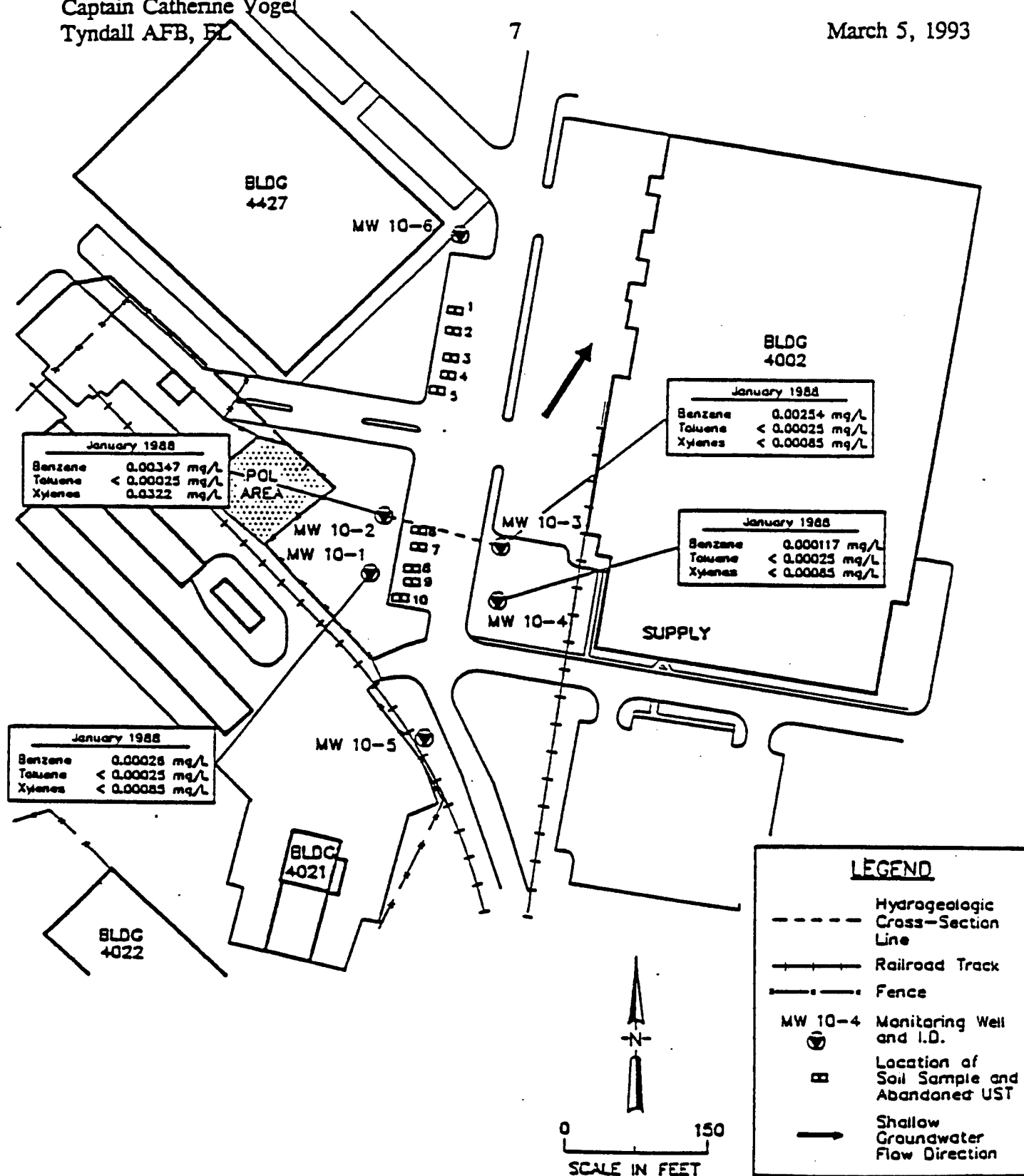


Figure 3. Schematic Diagram of SWMU 64

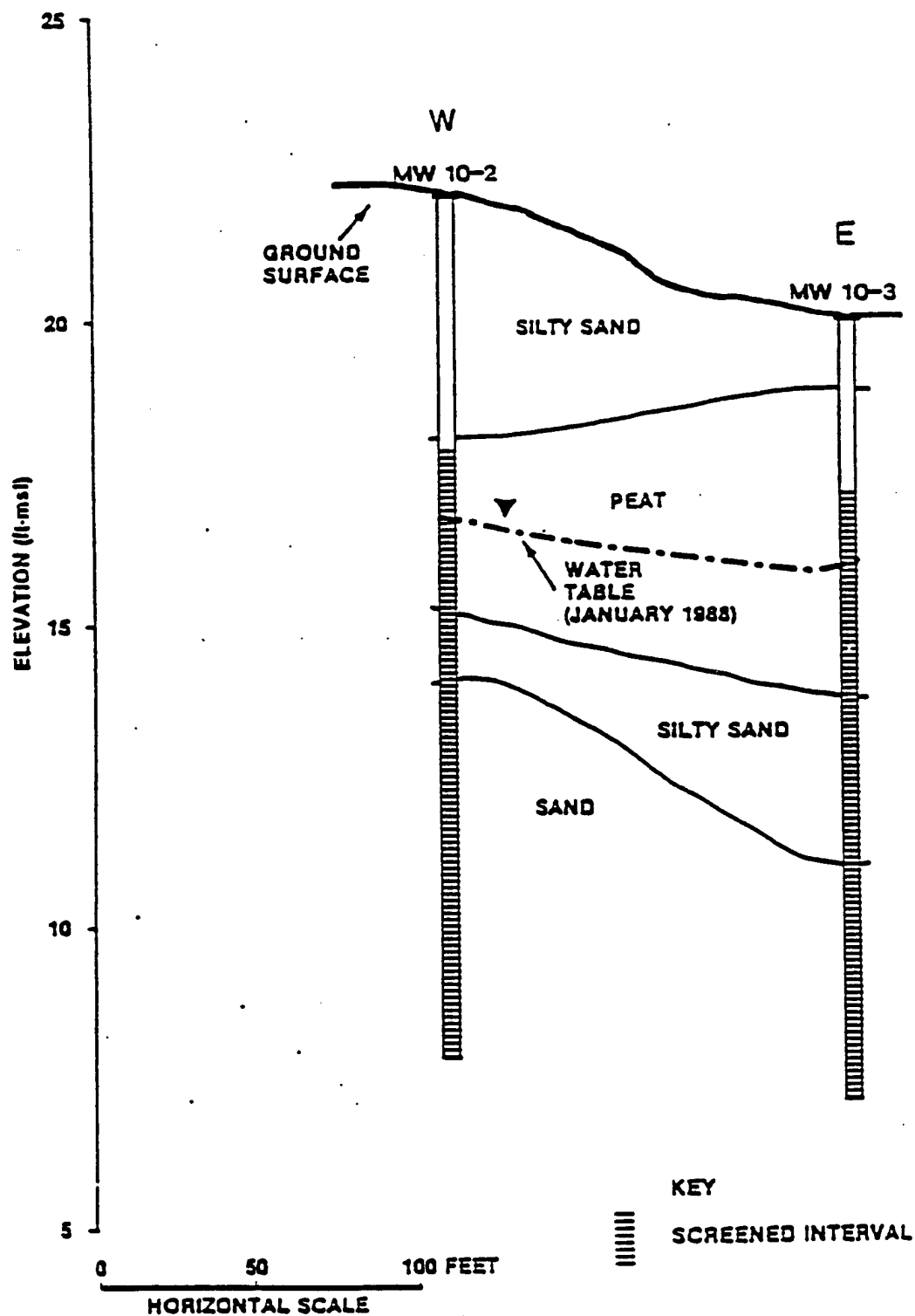


Figure 4. Hydrogeologic Cross Section of SWMU 64

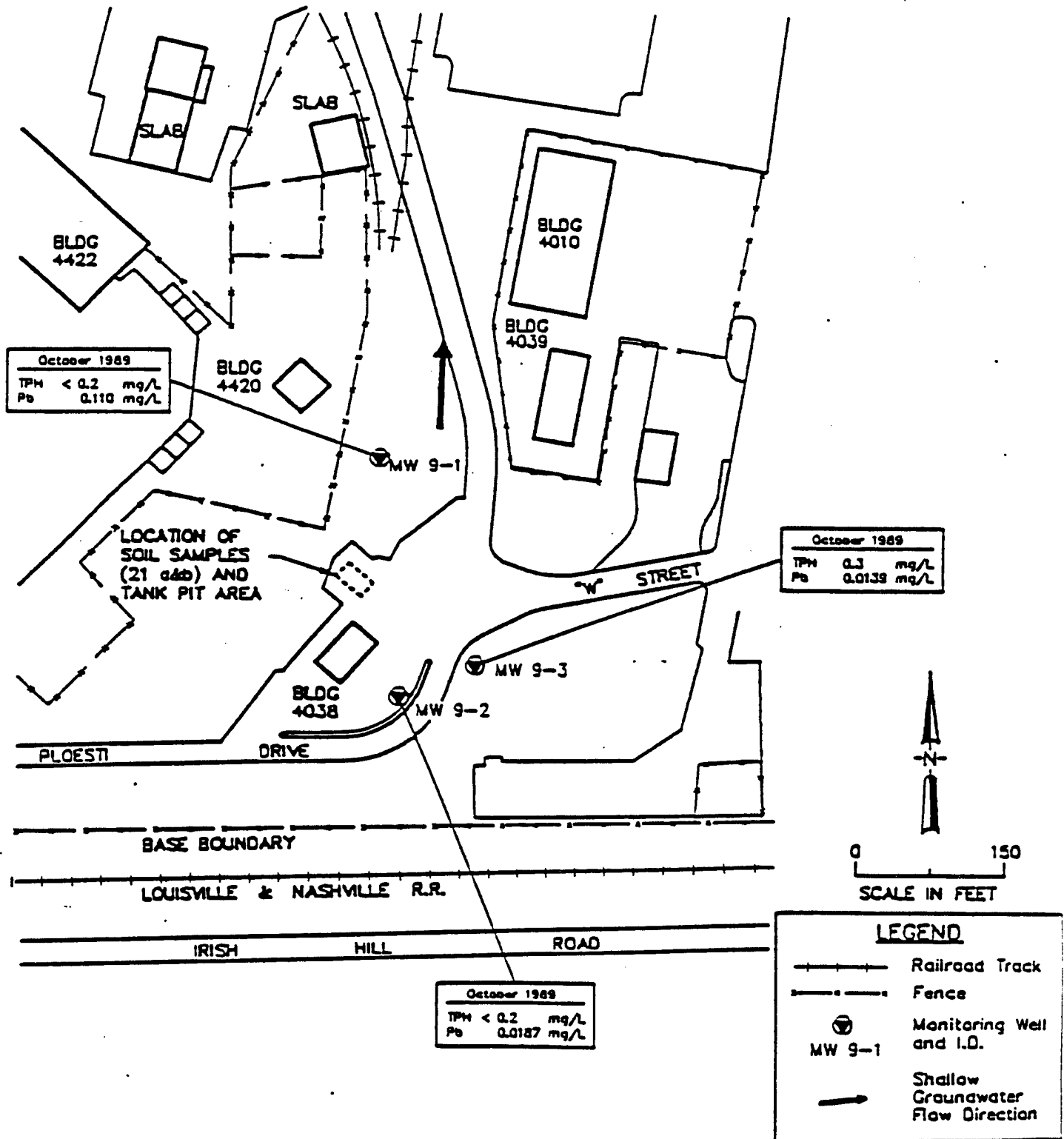


Figure 5. Schematic Diagram of SWMU 66

**APPENDIX B**

**ANALYTICAL REPORTS FOR AOC A, SWMU 66, AND THE BACKGROUND AREA**

**@ AIR TOXICS LTD.**

AN ENVIRONMENTAL ANALYTICAL LABORATORY

**WORK ORDER #: 9304159****Work Order Summary**

**CLIENT:** Mr. Jeff Kittel  
Battelle  
505 King Avenue  
Columbus, OH 43201

**BILL TO:** Accounts Payable  
Engineering Science  
1700 Broadway, Ste. 900  
Denver, CO 80290

**PHONE:** 614-424-6122  
**FAX:** 614-424-3667  
**DATE RECEIVED:** 4/27/93  
**DATE COMPLETED:** 5/5/93

**INVOICE #** 0744  
**P.O. #**  
**PROJECT #** G4468-0660  
**AMOUNT\$:** \$1,357.14

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>RECEIPT VAC./PRES.</u>	<u>PRICE</u>
01A	K-MPC-7.0'	TO-3	0 "Hg	\$120.00
02A	K-MPC-3.0'	TO-3	0 "Hg	\$120.00
03A	K-MPB-4.0'	TO-3	0 "Hg	\$120.00
04A	K-MPB-7.0'	TO-3	0 "Hg	\$120.00
05A	K-MPA-3.0'	TO-3	0 "Hg	\$120.00
06A	K-MPA-7.0'	TO-3	0 "Hg	\$120.00
07A*	K-BKG	TO-3	3.0 "Hg	\$120.00
08A	KI-MPB-3.0'	TO-3	0 "Hg	\$120.00
09A	KI-MPA-3.0'	TO-3	0 "Hg	\$120.00
10A	KI-VW-3.0-8.0'	TO-3	0 "Hg	\$120.00
10B	KI-VW-3.0-8.0' Duplicate	TO-3	0 "Hg	NC
11A	Method Spike	TO-3	NA	NC
12A	Lab Blank	TO-3	NA	NC
12B	Lab Blank	TO-3	NA	NC

*ACC-A*  
*SUMMA*

Misc Charges      1 Liter SUMMA Canister Preparation (10) @ \$10.00 each.      \$100.00  
Shipping (4/16/93)      \$57.14

**LAB NARRATIVE:**

\* The TPH result was referenced to Jet Fuel, but sample contains primarily C5 and less compounds.

CERTIFIED BY:

*Jonda L. Fummar*  
Laboratory Director

DATE:

*5/5/93*

**AIR TOXICS LTD.**

SAMPLE NAME: K-MPC-7.0'

ID#: 9304159-01A

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

<b>File Name:</b>	<b>6042814</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>2000</b>	<b>Date of Analysis: 4/28/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	2.0	6.2	Not Detected	Not Detected
Toluene	2.0	7.4	Not Detected	Not Detected
Ethyl Benzene	2.0	8.5	2.3	9.8
Total Xylenes	2.0	8.5	Not Detected	Not Detected

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042814</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>2000</b>	<b>Date of Analysis: 4/28/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	20	120	25000	160000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: K-MPC-3.0'

ID#: 9304159-02A

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

<b>File Name:</b>	<b>6042815</b>	<b>Date of Collection:</b>	<b>4/22/93</b>	
<b>Dil. Factor:</b>	<b>1000</b>	<b>Date of Analysis:</b>	<b>4/28/93</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	1.0	3.1	Not Detected	Not Detected
Toluene	1.0	3.7	Not Detected	Not Detected
Ethyl Benzene	1.0	4.2	1.8	7.6
Total Xylenes	1.0	4.2	1.0	4.2

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042815</b>	<b>Date of Collection:</b>	<b>4/22/93</b>	
<b>Dil. Factor:</b>	<b>1000</b>	<b>Date of Analysis:</b>	<b>4/28/93</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	10	62	21000	130000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: K-MPB-4.0'

ID#: 9304159-03A

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

<b>File Name:</b>	<b>6042816</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>10000</b>	<b>Date of Analysis: 4/28/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	10	31	1700	5300
Toluene	10	37	590	2200
Ethyl Benzene	10	42	140	590
Total Xylenes	10	42	310	1300

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042816</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>10000</b>	<b>Date of Analysis: 4/28/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	100	620	200000	1200000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: K-MPB-7.0'

ID#: 9304159-04A

**EPA METHOD TO-3**

(Aromatic Volatile Organics in Air)

**GC/PID**

File Name: 6042906 Date of Collection: 4/22/93

Dil. Factor: 10000 Date of Analysis: 4/29/93

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	10	31	1500	4700
Toluene	10	37	690	2500
Ethyl Benzene	10	42	61	260
Total Xylenes	10	42	150	640

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

File Name: 6042906 Date of Collection: 4/22/93

Dil. Factor: 10000 Date of Analysis: 4/29/93

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	100	620	200000	1200000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: K-MPA-3.0'

ID#: 9304159-05A

**EPA METHOD TO-3**

(Aromatic Volatile Organics in Air)

**GC/FID**

<b>File Name:</b>	<b>6042909</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>10000</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	10	31	1800	5600
Toluene	10	37	1000	3700
Ethyl Benzene	10	42	56	240
Total Xylenes	10	42	150	640

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042909</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>10000</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	100	620	190000	1200000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: K-MPA-7.0'

ID#: 9304159-06A

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

File Name: 6042910		Date of Collection: 4/22/93		
Dil. Factor: 10000		Date of Analysis: 4/29/93		
Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	10	31	1400	4400
Toluene	10	37	1000	3700
Ethyl Benzene	10	42	45	190
Total Xylenes	10	42	130	550

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

File Name: 6042910		Date of Collection: 4/22/93		
Dil. Factor: 10000		Date of Analysis: 4/29/93		
Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	100	620	160000	1000000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: K-BKG

ID#: 9304159-07A\*

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

<b>File Name:</b>	<b>6042911</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>7.5</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	0.008	0.023	Not Detected	Not Detected
Toluene	0.008	0.028	0.008	0.029
Ethyl Benzene	0.008	0.032	Not Detected	Not Detected
Total Xylenes	0.008	0.032	Not Detected	Not Detected

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042911</b>	<b>Date of Collection: 4/22/93</b>		
<b>Dil. Factor:</b>	<b>7.5</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	0.075	0.47	120	750

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: KI-MPB-3.0'

ID#: 9304159-08A

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

<b>File Name:</b>	<b>6042917</b>	<b>Date of Collection: 4/26/93</b>		
<b>Dil. Factor:</b>	<b>10</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	0.010	0.031	3.3	10
Toluene	0.010	0.037	0.23	0.85
Ethyl Benzene	0.010	0.042	0.065	0.28
Total Xylenes	0.010	0.042	0.30	1.3

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042917</b>	<b>Date of Collection: 4/26/93</b>		
<b>Dil. Factor:</b>	<b>10</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	0.10	0.62	150	930

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: KI-MPA-3.0'

ID#: 9304159-09A

**EPA METHOD TO-3**

(Aromatic Volatile Organics in Air)

**GC/PID**

File Name: 6042914		Date of Collection: 4/28/93		
Dil. Factor: 200		Date of Analysis: 4/29/93		
Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.20	0.62	9.0	28
Toluene	0.20	0.74	0.63	2.3
Ethyl Benzene	0.20	0.85	0.37	1.6
Total Xylenes	0.20	0.85	0.24	1.0

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

File Name: 6042914		Date of Collection: 4/26/93		
Dil. Factor: 200		Date of Analysis: 4/29/93		
Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	2.0	12	2400	15000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: KI-VW-3.0-8.0'

ID#: 9304159-10A

**EPA METHOD TO-3**

(Aromatic Volatile Organics in Air)

**GC/PID**

<b>File Name:</b>	<b>6042915</b>	<b>Date of Collection: 4/26/93</b>		
<b>Dil. Factor:</b>	<b>1000</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	1.0	3.1	56	170
Toluene	1.0	3.7	130	580
Ethyl Benzene	1.0	4.2	13	55
Total Xylenes	1.0	4.2	59	250

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042915</b>	<b>Date of Collection: 4/26/93</b>		
<b>Dil. Factor:</b>	<b>1000</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	10	62	22000	140000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: KI-VW-3.0-8.0' Duplicate  
ID#: 9304159-10B

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)

**GC/PID**

<b>File Name:</b>	<b>6042916</b>	<b>Date of Collection: 4/26/93</b>		
<b>Dil. Factor:</b>	<b>1000</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	1.0	3.1	55	170
Toluene	1.0	3.7	130	480
Ethyl Benzene	1.0	4.2	13	55
Total Xylenes	1.0	4.2	59	250

**TOTAL PETROLEUM HYDROCARBONS**  
**GC/FID**  
(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042916</b>	<b>Date of Collection: 4/26/93</b>		
<b>Dil. Factor:</b>	<b>1000</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	10	62	22000	140000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

**AIR TOXICS LTD.**

SAMPLE NAME: Method Spike

ID#: 9304159-11A

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

<b>File Name:</b>	<b>6042901</b>	<b>Date of Collection:</b> NA
<b>Dil. Factor:</b>	<b>1.0</b>	<b>Date of Analysis:</b> 4/29/93

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	% Recovery
Benzene	0.001	0.003	86
Toluene	0.001	0.004	86
Ethyl Benzene	0.001	0.004	84
Total Xylenes	0.001	0.004	85

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Gasoline)

<b>File Name:</b>	<b>6042901</b>	<b>Date of Collection:</b> NA
<b>Dil. Factor:</b>	<b>1.0</b>	<b>Date of Analysis:</b> 4/29/93

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	% Recovery
TPH*	0.010	0.062	97

\*TPH referenced to Jet Fuel (MW=156)

Container Type: NA

**AIR TOXICS LTD.**

SAMPLE NAME: Lab Blank

ID#: 9304159-12A

**EPA METHOD TO-3**

(Aromatic Volatile Organics in Air)

**GC/PID**

<b>File Name:</b>	<b>6042805</b>	<b>Date of Collection: NA</b>		
<b>Dil. Factor:</b>	<b>1.0</b>	<b>Date of Analysis: 4/28/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6042805</b>	<b>Date of Collection: NA</b>		
<b>Dil. Factor:</b>	<b>1.0</b>	<b>Date of Analysis: 4/28/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	0.010	0.062	Not Detected	Not Detected

\*TPH referenced to Jet Fuel (MW=156)

Container Type: NA

**AIR TOXICS LTD.**

SAMPLE NAME: Lab Blank

ID#: 9304159-12B

**EPA METHOD TO-3**  
(Aromatic Volatile Organics in Air)**GC/PID**

<b>File Name:</b>	<b>6042805</b>	<b>Date of Collection: NA</b>		
<b>Dil. Factor:</b>	<b>1.0</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

**TOTAL PETROLEUM HYDROCARBONS****GC/FID**

(Quantitated as Gasoline)

<b>File Name:</b>	<b>6042805</b>	<b>Date of Collection: NA</b>		
<b>Dil. Factor:</b>	<b>1.0</b>	<b>Date of Analysis: 4/29/93</b>		
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH*	0.010	0.040	Not Detected	Not Detected
C2 - C4** Hydrocarbons	0.010	0.018	Not Detected	Not Detected

\*TPH referenced to Gasoline (MW=100)

\*\*C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA



**11325 SUNRISE GOLD CIRCLE, SUITE 'E'**  
**RANCHO CORDOVA, CA 95742**  
**(916) 638-9892 • FAX (916) 638-9917**

# CHAIN OF CUSTODY RECORD

Page 1 of 1

PROJECT # G4468-0660 PO # \_\_\_\_\_  
REMARKS ~~Ben 4450~~ AOC A - BX Service Station COLLECTED BY (Signature) Jones E. Abbott

FIELD SAMPLE I.D.# SAMPLING MEDIA (Tenax, Canister etc.)

DATE/TIME

## ANALYSIS

VAC./PRESSURE

LAB I.D. #

K-MPC - 7.0'	CANISTER # 13391	22 APR 93 0729	BTEX / TPH	0" Hg
K-MPC - 3.0'	CANISTER # 11893	22 APR 93 0730		0" Hg
K-MPB - 4.0'	CANISTER # 13393	22 APR 93 0805		0" Hg
K-MPB - 1.0'	CANISTER # 13392	22 APR 93 0745		0" Hg
K-MPA - 3.0'	CANISTER # AT 9307	22 APR 93 0800		0" Hg
K-MPA - 7.0'	CANISTER # AT 9319	22 APR 93 0805		0" Hg
<del>K-MPA</del> K-BKG	CANISTER # AT 9308	22 APR 93 1440		3" Hg

**LAB USE ONLY**

RELINQUISHED BY: DATE/TIME

RECEIVED BY: DATE/TIME

RELINQUISHED BY: DATE/TIME

RECEIVED BY: DATE/TIME

26 APR 93 / 1100 hrs

~~Handwritten signature~~ - Article

5

4/12/77 08:50

SHIPPER NAME

AIR BILL #

OPENED BY: DATETIME

TEMP(°C)

CONDITION

REMARKS

[illegible]



**AIR TOXICS LTD.**

AN ENVIRONMENTAL ANALYTICAL LABORATORY

11325 SUNRISE GOLD CIRCLE, SUITE 'E'  
RANCHO CORDOVA, CA 95742  
(916) 638-9892 • FAX (916) 638-9917

## CHAIN OF CUSTODY RECORD

Page 1 of 1

PROJECT # G4468-0660 PO # \_\_\_\_\_

REMARKS Page 4038 - SMU 66 MILITARY/ SERVICE STATION COLLECTED BY (Signature) James E. Abbott

FIELD SAMPLE I.D.#	SAMPLING MEDIA (Tenax, Canister etc.)	DATE/TIME	ANALYSIS	VAC./PRESSURE	LAB I.D. #
11A KI-MPB-3.0'	CANISTER # AT 9311	26 APR 93 0941	BTEX / TPH	0"Hg	
11A KI-MPA-3.0'	CANISTER # AT 9314	26 APR 93 0930	↓	0"Hg	
11A KI-VW-3.0-8.0'	CANISTER # AT 9310	26 APR 93 0948		0"Hg	

RELINQUISHED BY: DATE/TIME 26 APR 93 / 1100 hrs RECEIVED BY: DATE/TIME James E. Abbott RELINQUISHED BY: DATE/TIME ATC RECEIVED BY: DATE/TIME 4/27/93 08:50

### LAB USE ONLY

SHIPPER NAME \_\_\_\_\_ AIR BILL # \_\_\_\_\_ OPENED BY: DATE/TIME \_\_\_\_\_ TEMP (°C) \_\_\_\_\_ CONDITION \_\_\_\_\_

REMARKS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**GC VOLATILES DATA PACKAGE**

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.: 4996

% Moisture: 6.6

Client ID: K-IW-1-6.5'-7.0'

Matrix: SOIL

Laboratory ID: 4996-01

Level: MEDIUM

Sample wt./vol : 5 gm

Unit: ug/Kg

Dilution Factor: 1

Date Analyzed: 05-03-93

Date Confirmed: NA  
-----

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	390	NA	37
Ethyl Benzene	850	NA	39
Toluene	110	NA	57
Xylenes (total)	210	NA	97

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *inf*GROUP LEADER: *AS* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4996

% Moisture: 9.5

Client ID:K-IW-3-5.5'-6.0'

Matrix:SOIL

Laboratory ID:4996-02

Level:LOW

Sample wt./vol : 1 g.

Unit:ug/Kg

Dilution Factor: 5

Date Analyzed:04-30-93  
Date Confirmed:NA-----

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	ND	NA	3.3
Ethyl Benzene	3.7	NA	2.7
Toluene	12	NA	4.1
Xylenes (total)	59	NA	9.3

-----ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *Ann F*GROUP LEADER: *PH* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.: 4996

% Moisture: 10.8

Client ID: K-EW-3-5.5'-6.0'

Matrix: SOIL

Laboratory ID: 4996-03

Level: MEDIUM

Sample wt./vol : 100 ul.

Unit: ug/Kg

Dilution Factor: 1

Date Analyzed: 05-04-93  
Date Confirmed: NA-----

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	ND	NA	39
Ethyl Benzene	ND	NA	40
Toluene	ND	NA	59
Xylenes (total)	ND	NA	102

-----ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *Am A*GROUP LEADER: *PH* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.: 4996

% Moisture: 6.8

Client ID: K-EW-1-5.0'-5.5'

Matrix: SOIL

Laboratory ID: 4996-04

Level: LOW

Sample wt./vol : 5 g.

Unit: ug/Kg

Dilution Factor: 1

Date Analyzed: 05-04-93  
Date Confirmed: NA-----

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	4.8	NA	0.63
Ethyl Benzene	0.63	NA	0.50
Toluene	2.9	NA	0.79
Xylenes (total)	1.9	NA	1.82

-----ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *Aug F*GROUP LEADER: *AS 5/13/93*

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way  
Berkeley, CA 94710

GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.: 4996

% Moisture: 0

Client ID: (BLANK)

Matrix: SOIL

Laboratory ID: MSVG2930430

Level: LOW

Sample wt./vol : 5 g.

Unit: ug/Kg

Dilution Factor: 1

Date Analyzed: 04-30-93  
Date Confirmed: NA

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	ND	NA	0.59
Ethyl Benzene	ND	NA	0.47
Toluene	ND	NA	0.74
Xylenes (total)	ND	NA	1.70

ND-Not Detected  
NA-Not Applicable  
D-Dilution Factor

ANALYST: *fm*

GROUP LEADER: *PH* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4996

% Moisture: 0

Client ID:(BLANK)

Matrix:SOIL

Laboratory ID:MWVG2930503

Level:MEDIUM

Sample wt./vol : 100 ul.

Unit:ug/Kg

Dilution Factor: 1

Date Analyzed:05-03-93

Date Confirmed:NA  
-----

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	ND	NA	35
Ethyl Benzene	ND	NA	36
Toluene	ND	NA	53
Xylenes (total)	ND	NA	91

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *An F*GROUP LEADER: *PA*

5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4996

% Moisture: 0

Client ID:(BLANK)

Matrix:SOIL

Laboratory ID:MWVG2930504

Level:MEDIUM

Sample wt./vol : 100 ul.

Unit:ug/Kg

Dilution Factor: 1

Date Analyzed:05-04-93

Date Confirmed:NA  
-----

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	ND	NA	35
Ethyl Benzene	ND	NA	36
Toluene	ND	NA	53
Xylenes (total)	ND	NA	91

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *Am A*GROUP LEADER: *CH* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4996

% Moisture: 0

Client ID:(BLANK)

Matrix:SOIL

Laboratory ID:MSVG2930504

Level:LOW

Sample wt./vol : 5 g.

Unit:ug/Kg

Dilution Factor: 1

Date Analyzed:05-04-93  
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Detection Limit
Benzene	ND	NA	0.59
Ethyl Benzene	ND	NA	0.47
Toluene	ND	NA	0.74
Xylenes (total)	ND	NA	1.70

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *Am F*GROUP LEADER: *PH* 5/13/93

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

VOLATILE METHOD BLANK SUMMARY

LAB FILE ID: V2P849 (MSVG2930430)

TIME ANALYZED: 1337

DATE ANALYZED: 04-30-93

MATRIX: SOIL

COLUMN ID: VGC2 VOCOL  
-----

CLIENT ID	LABORATORY NO.	LAB FILE ID.	TIME ANALYZED
BLANK SPIKE	SSVG2930430A	V2P858	1912
BLANK SPIKE DUP	SSVG2930430B	V2P859	1950
K1-IW-3-5.5'-6.0'	4996-02	V2P862	2144

ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710

VOLATILE METHOD BLANK SUMMARY

LAB FILE ID: V2P866 (MWVG2930503)

TIME ANALYZED: 1641

DATE ANALYZED: 05-03-93

MATRIX: ~~WATER~~ <sup>Soil RL 5/17/93</sup>

COLUMN ID: VGC2 VOCOL

CLIENT ID	LABORATORY NO.	LAB FILE ID.	TIME ANALYZED
BLANK SPIKE	SWVG2930503A	V2P867	1719
BLANK SPIKE DUP	SWVG2930503B	V2P868	1756
K-IW-1-6.5'-7.0'	4996-01	V2P870	1911

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

VOLATILE METHOD BLANK SUMMARY

LAB FILE ID: V2P874 (MWVG2930504)

TIME ANALYZED: 1222

DATE ANALYZED: 05-04-93

MATRIX: <sup>Soil 5/7/93</sup> ~~WATER~~ *AL*

COLUMN ID: VGC2 VOCOL  
-----

CLIENT ID

LABORATORY NO.

LAB  
FILE ID.

TIME  
ANALYZED  
-----

K-EW-1-5.0'-5.5'

4996-03

V2P875

1300

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

VOLATILE METHOD BLANK SUMMARY

LAB FILE ID: V2P877 (MSVG2930504)

TIME ANALYZED: 1414

DATE ANALYZED: 05-04-93

MATRIX: SOIL

COLUMN ID: VGC2 VOCOL

=====

CLIENT ID	LABORATORY NO.	LAB FILE ID.	TIME ANALYZED
=====	=====	=====	=====
BLANK SPIKE	SSVG2930504A	V2P879	1744
BLANK SPIKE DUP	SSVG2930504B	V2P880	1822
K-EW-3-5.0'-5.5'	4996-04	V2P878	1707

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

FORM II VOA-1 (1/87 REV.)  
EPA METHOD 8020 BETX

MATRIX: SOIL (MEDIUM)

COLUMN ID: VGC2 VOCOL

-----  
LABORATORY NO.

a,a,a-Trifluorotoluene  
-----

MWVG2930503	114
SWVG2930503A	92
SWVG2930503B	92
4996-01	106
MWVG2930504	112
4996-03	104

\* - Out of limits

Limits = 50-150%

IS-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710

FORM II VOA-1 (1/87 REV.)  
EPA METHOD 8020 BETX

MATRIX: SOIL

COLUMN ID: VGC2 VOCOL

LABORATORY NO.

a,a,a-Trifluorotoluene

MSVG2930430	113
3SVG2930430A	91
3SVG2930430B	94
4996-02	114
MSVG2930504	115
3SVG2930504A	95
3SVG2930504B	92
4996-04	113

\* - Out of limits

Limits = 50-150%

**TOTAL RECOVERABLE PETROLEUM HYDROCARBONS  
DATA PACKAGE**

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way  
Berkeley, CA 94710

ORGANIC ANALYTICAL REPORT

Work Order NO.: 4996

Parameter: TPH

Matrix: Soil

Unit: mg/Kg

Analytical

Method: 418.1

Date Extracted: 04/28/93

QC Batch NO.: S93QCB021TPH


Date Analyzed: 04/29/93

Sample ID:	Client ID:	Result	Reporting Limit	Percent Moisture
4996-01	K-IW-1-6.5'-7.0'	36	4	6.56
4996-02	K-IW-3-5.5'-6.0'	64	4	9.45
4996-03	K-EW-3-5.5'-6.0'	247	4	10.84
4996-04	K-EW-1-5.0'-5.5'	ND	4	6.84
MSTPH930428	METHOD BLANK	ND	4	NA

NA\_ Not Analyzed  
ND\_ Not Detected

ANALYST:

GROUP LEADER:





INORGANICS DATA PACKAGE

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEE.Work Order: 4996  
Matrix: SolidClient's ID: K-IW-1 K-IW-3 K-EW-3  
-6.0'-6.5' -4.5'-5.0' -5.0'-5.5'

Sample Date: 04/21/93 04/22/93 04/22/93

% Moisture:

Lab ID: 4996.01 4996.02 4996.03

Parameter	Results	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	67. 610. 270.	SM 403(M)	50	mg/Kg CaCO3	05/07/93
Moisture	6.6 9.4 10.8	ASTM D2216	.1	% by wt	04/29/93
pH	6.2 7.7 7.5	EPA 9045	NA	pH Units	04/29/93

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable

ND- Not Detected

ANALYST: Don HeatonGROUP LEADER: William S. Long

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEEWork Order: 4996  
Matrix: Solid

Client's ID:

K-EW-1  
-4.0'-5.0'Sample Date: 04/21/93  
% Moisture:  
Lab ID: 4996.04

Parameter	Results	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	46.	SM 403(M)	50	mg/Kg CaCO3	05/07/93
Moisture	6.8	ASTM D2216	.1	% by wt	04/29/93
pH	6.6	EPA 9045	NA	pH Units	04/29/93

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable  
ND- Not Detected

ANALYST:

Don J. Eaton

GROUP LEADER:

[Signature]

CASE NARRATIVE  
WORK ORDER NO. 4996  
METALS - IRON

Client IDs were abridged by the laboratory to facilitate computer entry of analytical data. The following should be used as a reference:

<u>CLIENT ID</u>	<u>ABRIDGED ID</u>
K-IW-1-6.0'-6.5'	KIW6.5 (IRON)
K-IW-3-4.5'-5.0'	KIW5.0 (IRON)
K-EW-3-5.0'-5.5'	KEW5.5 (IRON)
K-EW-1-4.0'-5.0'	KEW5.0 (IRON)

The serial dilution sample result for iron did not agree with the undiluted result within 10%, and the diluted result was greater than ten times the iron MDL. All iron results in this batch are therefore flagged with "E".

## INORGANIC ANALYSES DATA SHEET

KING. E

CLIENT SAMPLE ID

KIW5. <sup>0</sup>~~8~~ <sup>122</sup> 5/11/93

SDG No.: BG-4.5

Lab Sample ID: 4996.02

Date Sampled : 04/22/93

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

## INORGANIC ANALYSES DATA SHEET

KEW5. 5'

SDG No. : BG-4.5

Lab Sample ID: 4996.03

Date Sampled : 04/22/93

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

## INORGANIC ANALYSES DATA SHEET

KEN5.0

SDG No.: BG-4.5

Lab Sample ID: 4996.04

Date Sampled : 04/21/93

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

## INORGANIC ANALYSES DATA SHEET

PBLANK

## LABORATORY CONTROL SAMPLE (BLANK SPIKE)

Contract: AFCEE

SDG No.: BG-4.5

aqueous LCS Source: \_\_\_\_\_

FORM VII - IN

## LABORATORY CONTROL SAMPLE (BLANK SPIKE)

Contract: AFCEE

SDG No.: BG-4.5

Aqueous LCS Source: \_\_\_\_\_

3/90

CLIENT SAMPLE ID

LCSSD

% Solids for Sample: 100.0                      % Solids for Duplicate: 100.0

[illegible]

## ICP SERIAL DILUTION

MPB-50L

Contract: AFCEE

Case No.: 4974S

SAS No. :

SDG No.: BG-4.5

Level (low/med): LOW

[illegible]

## Method Detection Limits (Annually)

Contract: AFCEE

Case No.: 4974S

SAS No. :

SDG No.: BG-4.5

TCP ID Number:

TJA 61 M

Date: 08/31/92

Flame AA ID Number :

Matrix: SOIL

Turnace AA ID Number :

(ug/L in 1.00g to 100ml digestate)

[illegible]

Comments:

## PREPARATION LOG

Contract: AFCEE

SDG No. : BG-4.5

Method: P

[illegible]

FORM XIII - IN

ILMO2.1

Engineering Science - Berkeley Laboratory  
Inorganics Report

ANALYSIS RUN LOG

Lab Name: E\_S\_\_BERKELEY\_LABORATORY\_\_

Contract: AFCEE\_\_

Lab Code: ESBL\_\_ Case No.: 4974S\_\_

SAS No.: \_\_\_\_\_ SDG No.: BG-4.5

Instrument ID Number: TJA 61 M\_\_

Method: P\_\_

Start Date: 05/06/93

End Date: 05/06/93

EPA Sample No.	D/F	Time	% R	Analytes																	
				F	E																
STD1	1.00	1050		X																	
STD2	1.00	1055		X																	
STD3	1.00	1101		X																	
STD4	1.00	1107		X																	
ICV	1.00	1112		X																	
ICB	1.00	1118		X																	
ICSA	1.00	1124		X																	
ICSAB	1.00	1129		X																	
CRI	1.00	1135																			
ZZZZZZ	1.00	1141																			
PBLANK	1.00	1146		X																	
LCSS	1.00	1152		X																	
LCSSD	1.00	1158		X																	
MPB-50	1.00	1203		X																	
MPB-50L	1.00	1209		X																	
MPA-40	1.00	1214		X																	
CCV	1.00	1220		X																	
CCB	1.00	1226		X																	
MPA3.0	1.00	1231		X																	
MPC3.0	1.00	1237		X																	
VWA3.0	1.00	1243		X																	
BG-4.5	1.00	1248		X																	
MP1-24	1.00	1254		X																	
VW1-30	1.00	1300		X																	
MP2-25	1.00	1305		X																	
MP4-22	1.00	1311		X																	
WH-MPA	1.00	1317		X																	
CCV	1.00	1322		X																	
CCB	1.00	1328		X																	
KIW6.5	1.00	1334		X																	
KIW5.5o	1.00	1339		X																	
KEW5.5	1.00	1345		X																	

## ANALYSIS RUN LOG



**TOTAL PHOSPHORUS  
TOTAL KJELDAHL NITROGEN  
SOIL CLASSIFICATION  
DATA PACKAGE**

## ENGINEERING-SCIENCE

## CHAIN OF CUSTODY RECORD FOR WATER SAMPLES

US JOB NO.	PROJECT NAME/LOCATION	PRESERVATIVES REQUIRED										ANALYSES REQUIRED										REMARKS	
	W.O. 4996																					Sequim Lab	
FIELD CONTACT: R. Charbone																							
SAMPLER NAMES & SIGNATURES																							
DATE	TIME	FIELD SAMPLE IDENTIFIER	Particle Size	T. Phosphorus	TKN	4996-1C	-2C	-3C	-4C														
1/21/93	1050	K-IW-1-6.0-6.5'	X	X	X	X																Sub-out	
1/22/93	1736	K-IW-3-4.5-5.0'	X	X	X																		
d	1910	K-EW-3-5.0-5.5'	X	X	X																		
1/21/93		K-EW-1-4.0-5.0'	X	X	X																		

DATE: 4/27/93 TIME: 0945

ON RECEIPT: CUSTODY DEALT? °C

FIELD CUSTODY RELINQUISHED BY: R. Charbone

AIRBILL #

SHIPPED VIA:

DATE: 4/28/93 TIME: 1125

RECEIVED FOR LABORATORY BY: S. [Signature]



# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: 4996  
Sample Descript: Soil  
Analysis for: Nitrogen:Kjeldahl  
First Sample #: 3DD2501

Sampled: 4/21-4/22/93  
Received: Apr 28, 1993  
Analyzed: May 4, 1993  
Reported: May 25, 1993

## LABORATORY ANALYSIS FOR:

Nitrogen:Kjeldahl

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
3DD2501	4996.1	20	54
3DD2502	4996.2	20	31
3DD2503	4996.3	20	76
3DD2504	4996.4	20	N.D.

THIS REPORT HAS BEEN  
APPROVED AND REVIEWED BY

5/27/93

ESB PROJECT MANAGER  
FACE

DATE

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

for Jennifer A. Nelson  
Project Manager

Please Note:

Sample results are reported on a dry weight basis. % moistures faxed by client 5/14/93.

3DD2501.ENG <1>



# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: 4996  
Sample Descript: Soil  
Analysis for: Phosphorus  
First Sample #: 3DD2501

Sampled: 4/21-4/22/93  
Received: Apr 28, 1993  
Analyzed: May 21, 1993  
Reported: May 25, 1993

## LABORATORY ANALYSIS FOR:

Phosphorus

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
3DD2501	4996.1	10	28
3DD2502	4996.2	10	25
3DD2503	4996.3	10	61
3DD2504	4996.4	10	27

THIS REPORT HAS BEEN  
APPROVED AND REVIEWED BY

  
ESBL PROJECT MANAGER  
PAC

5/27/93

DATE

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

  
Jennifer A. Nelson  
Project Manager

### Please Note:

Sample results are reported on a dry weight basis. % moistures faxed by client 5/14/93.  
Samples were analyzed by 365.3 but due to matrix interference were reanalyzed by 365.2.

3DD2501.ENG <2>



# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: 4996  
Matrix: Soil  
QC Sample Group: 3DD2501-04

Reported: May 25, 1993

## QUALITY CONTROL DATA REPORT

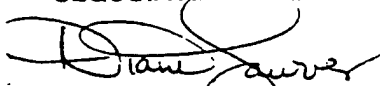
ANALYTE		
	TKN	Phosphorus
Method:	351.4	365.2
Analyst:	N. Northey	K. Follett
Conc. Spiked:	4000	0.50
Units:	mg/kg	mg/kg
LCS Batch#:	LCS050493	LCS052193
Date Prepared:	5/4/93	5/21/93
Date Analyzed:	5/4/93	5/21/93
Instrument I.D.#:	N/A	N/A
LCS % Recovery:	98	100
Control Limits:	80-120	80-120

MS/MSD Batch #:	3DD9501	3E65303
Date Prepared:	5/4/93	5/21/93
Date Analyzed:	5/4/93	5/21/93
Instrument I.D.#:	N/A	N/A
Matrix Spike % Recovery:	89	93
Matrix Spike Duplicate % Recovery:	87	83
Relative % Difference:	2.3	11

THIS REPORT HAS BEEN  
APPROVED AND REVIEWED BY

 5/27/93  
ESBL PROJECT MANAGER DATE  
PAC

SEQUOIA ANALYTICAL

  
Jennifer A. Nelson  
Project Manager

**Please Note:**

The LCS is a control sample of known, interferent free matrix that is analyzed using the same reagents, preparation and analytical methods employed for the samples. The LCS % recovery data is used for validation of sample batch results. Due to matrix effects, the QC limits for MS/MSD's are advisory only and are not used to accept or reject batch results.

3DD2501.ENG <3>

# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/21/93

Lab ID: 9304D25-01

Client ID: 4996-1

Sample Description: SOIL

### SIEVE TEST

A. Total weight of sample:

168.45 g

B. Weight retained in No. 10 sieve:

4.94 g

C. % passing No. 10 sieve:

97.07 %

Sieve test for weight  
retained in a No. 10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	4.94	2.93	2.93	97.07
No. 200	137.45	81.60	84.53	15.47

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. in mm (S)	% SUSPENDED (P)
2	21	16	12	14.3	0.0360	18.1
5	21	16	12	14.3	0.0228	18.1
10	21	15	11	14.5	0.0162	16.6
15	21	14	10	14.7	0.0133	15.1
25	21	14	10	14.7	0.0103	15.1
40	21	13	9	14.8	0.0082	13.6
60	21	12	8	15	0.0067	12.1
90	21	11	7	15.2	0.0055	10.6
120	21	11	7	15.2	0.0048	10.6
1440	21	9	5	15.5	0.0014	7.5

Weight of soil used in hydrometer test (D):

65 g

Hydroscopic moisture correction factor (G):

0.99

Specific gravity (Assumed):

2.65

Dispersing agent correction factor (E):

3

Meniscus correction factor (F):

1

Temp./Spec. gravity dependant constant (K):

0.01348

### Formulas:

$$R = H - E - F$$

$$S = K[\text{SQRT}(L/T)]$$

$$P = (R/W)100$$

$$W = (J \times 100)/C$$

$$J = D \times G$$

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PACE

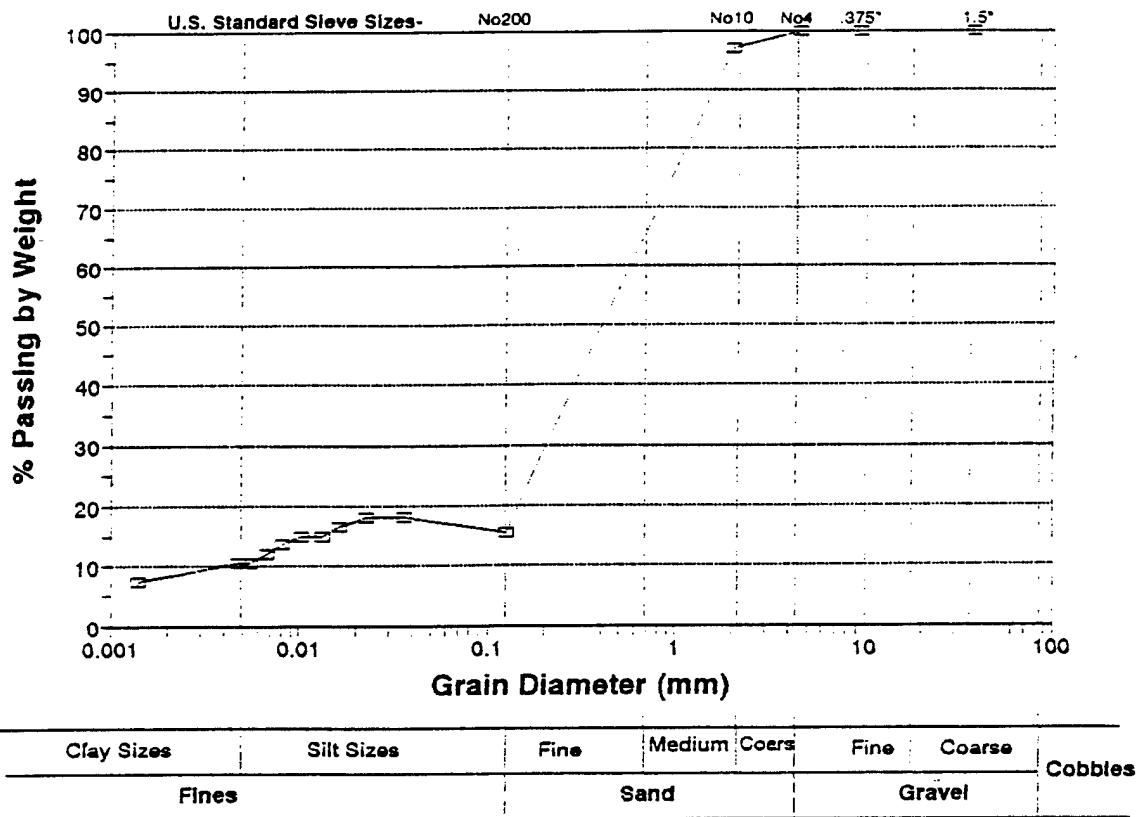
5/27/93  
DATE

Method: ASTM D422-63

Analyzed: 5/21/93

Lab ID: 9304D25-01

## Graph of Acquired Data



## Graphing Data:

Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	97.07
0.127	15.47
0.0360	18.10
0.0228	18.10
0.0162	18.59
0.0133	15.08
0.0103	15.08
0.0082	13.58
0.0067	12.07
0.0055	10.56
0.0048	10.56
0.0014	7.54

## Sample Composition:

(1) Gravel, passing 3-in. and retained on No. 4 sieve	0.0 %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve	87.5 %
(3) Silt size, 0.074 to 0.005 mm	2.0 %
(4) Clay size, smaller than 0.005 mm	10.6 %

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*RL* 5/27/93  
ESBL PROJECT MANAGER DATE  
PAGE

# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/21/93

Lab ID: 9304D25-02

Client ID: 4662-2

Sample Description: SOIL

### SIEVE TEST

A. Total weight of sample: 213.29 g  
B. Weight retained in No.10 sieve: 0.4 g  
C. % passing No.10 sieve: 99.81 %

Sieve test for weight  
retained in a No.10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	0.40	0.19	0.19	99.81
No. 200	172.00	80.64	80.83	19.17

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (H)	CORRECTED READING (F)	(L)	PARTICLE DIAM. in mm (S)	% SUSPENDED (P)
2	21	15	11	14.5	0.0363	17.1
5	21	13	9	14.8	0.0232	14.0
10	21	12	8	15	0.0165	12.4
15	21	11	7	15.2	0.0136	10.9
25	21	10	6	15.3	0.0105	9.3
40	21	9	5	15.5	0.0084	7.8
60	21	9	5	15.5	0.0069	7.8
90	21	8	4	15.6	0.0056	6.2
120	21	8	4	15.6	0.0049	6.2
1440	21	6	2	16	0.0014	3.1

Weight of soil used in hydrometer test (D):  
Hydrosopic moisture correction factor (G):  
Specific gravity (Assumed):  
Dispersing agent correction factor (E):  
Meniscus correction factor (F):  
Temp./Spec. gravity dependant constant (K):

65 g  
0.99  
2.65  
3  
1  
0.01348

### Formulas:

$R = H - E - F$   
 $S = K[\text{SQRT}(L/T)]$   
 $P = (R/W)100$   
 $W = (J \times 100)/C$

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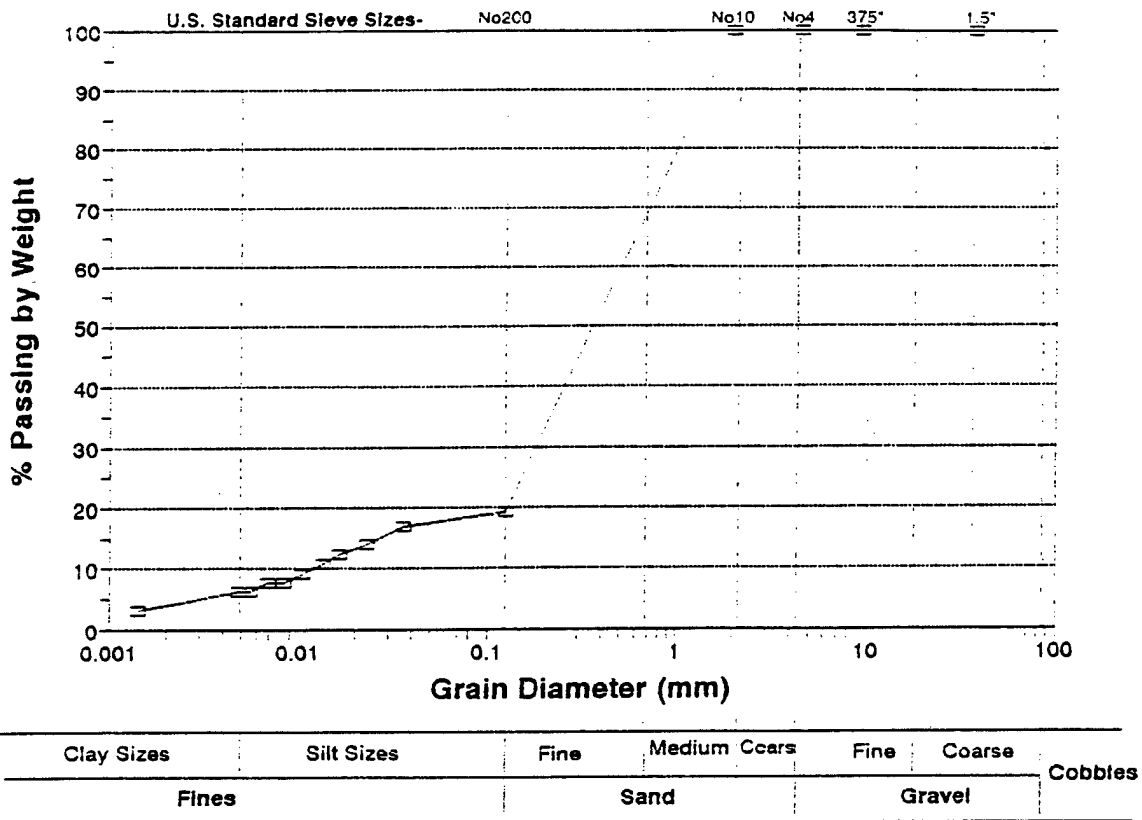


5/27/93

PROJECT MANAGER  
PACE

DATE

## Graph of Acquired Data



### Graphing Data:

Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	99.81
0.127	19.17
0.0363	17.06
0.0232	13.96
0.0165	12.41
0.0136	10.86
0.0105	9.31
0.0084	7.76
0.0069	7.76
0.0056	6.20
0.0049	6.20
0.0014	3.10

### Sample Composition:

(1) Gravel, passing 3-in. and retained on No. 4 sieve	0.0 %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve	81.0 %
(3) Silt size, 0.074 to 0.005 mm	12.8 %
(4) Clay size, smaller than 0.005 mm	6.2 %

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# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/21/93

Lab ID: 9304D25-03

Client ID: 4996-3

Sample Description: SOIL

### SIEVE TEST

A. Total weight of sample:	192.36 g
B. Weight retained in No.10 sieve:	5.22 g
C. % passing No.10 sieve:	97.29 %

Sieve test for weight  
retained in a No.10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	5.22	2.71	2.71	97.29
No. 200	159.95	83.15	85.87	14.13

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. in mm (S)	% SUSPENDED (P)
2	21	15	11	14.5	0.0363	16.6
5	21	14	10	14.7	0.0231	15.1
10	21	13	9	14.8	0.0164	13.6
15	21	13	9	14.8	0.0134	13.6
25	21	12	8	15	0.0104	12.1
40	21	12	8	15	0.0083	12.1
60	21	11	7	15.2	0.0068	10.6
90	21	10	6	15.3	0.0056	9.1
120	21	10	6	15.3	0.0048	9.1
1440	21	10	6	15.3	0.0014	9.1

Weight of soil used in hydrometer test (D):  
Hydroscopic moisture correction factor (G):  
Specific gravity (Assumed):  
Dispersing agent correction factor (E):  
Meniscus correction factor (F):  
Temp./Spec. gravity dependant constant (K):

65 g
0.99
2.65
3
1
0.01348

Formulas:

$$R = H - E - F$$


$$S = K[\text{SQRT}(L/T)]$$

$$P = (R/W)100$$

$$W = (J \times 100)/C$$

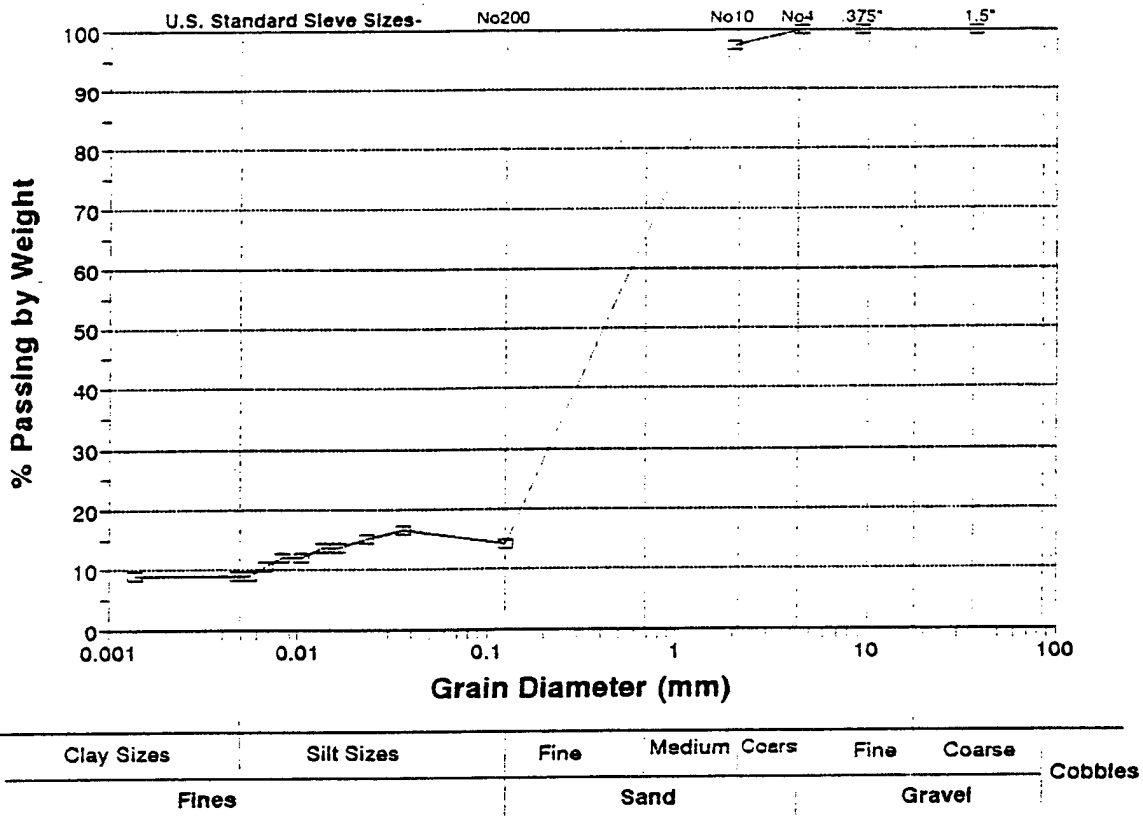
$$J = D \times G$$

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7/27/93  
DATE

## Graph of Acquired Data



### Graphing Data:

Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	97.29
0.127	14.13
0.0363	16.63
0.0231	15.12
0.0164	13.61
0.0134	13.61
0.0104	12.09
0.0083	12.09
0.0068	10.58
0.0056	9.07
0.0048	9.07
0.0014	9.07

### Sample Composition:

(1) Gravel, passing 3-in. and retained on No. 4 sieve	0.0 %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve	88.6 %
(3) Silt size, 0.074 to 0.005 mm	2.4 %
(4) Clay size, smaller than 0.005 mm	9.1 %

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# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/21/93

Lab ID: 9304D25-04

Client ID: 4996-4

Sample Description: SOIL

### SIEVE TEST

A. Total weight of sample:	215.48 g
B. Weight retained in No.10 sieve:	0.52 g
C. % passing No.10 sieve:	99.76 %

Sieve test for weight  
retained in a No.10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	0.52	0.24	0.24	99.76
No. 200	197.91	91.85	92.09	7.91

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. in mm (S)	% SUSPENDED (P)
2	21	10	6	15.3	0.0373	9.3
5	21	10	6	15.3	0.0236	9.3
10	21	9	5	15.5	0.0168	7.8
15	21	9	5	15.5	0.0137	7.8
25	21	9	5	15.5	0.0106	7.8
40	21	9	5	15.5	0.0084	7.8
60	21	8	4	15.8	0.0069	6.2
90	21	8	4	15.6	0.0056	6.2
120	21	7	3	15.8	0.0049	4.7
1440	21	7	3	15.8	0.0014	4.7

Weight of soil used in hydrometer test (D):  
Hydroscopic moisture correction factor (G):  
Specific gravity (Assumed):  
Dispersing agent correction factor (E):  
Meniscus correction factor (F):  
Temp./Spec. gravity dependant constant (K):

65 g
0.99
2.65
3
1
0.01248

#### Formulas:

$$R = H - E - F$$

$$S = K[\text{SQRT}(L/T)]$$

$$P = (R/W)100$$

$$W = (J \times 100)/C$$

$$J = D \times G$$

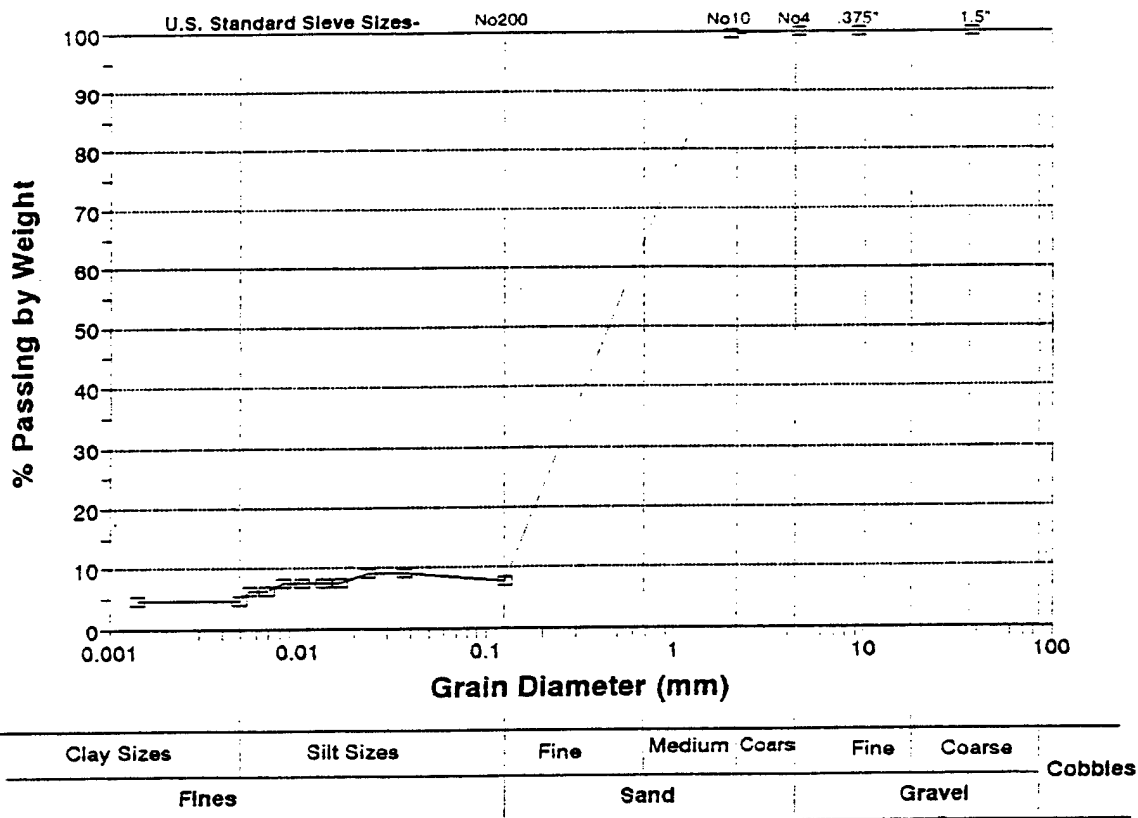
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5/27/93

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## Graph of Acquired Data



### Graphing Data:

Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	99.76
0.127	7.91
0.0373	9.30
0.0236	9.30
0.0168	7.75
0.0137	7.75
0.0106	7.75
0.0084	7.75
0.0069	6.20
0.0056	6.20
0.0049	4.65
0.0014	4.65

### Sample Composition:

- |   |        |
|---|--------|
| (1) Gravel, passing 3-in. and retained on No. 4 sieve       | 0.0 %  |
| (2) Sand, passing No. 4 sieve and retained on No. 200 sieve | 92.3 % |
| (3) Silt size, 0.074 to 0.005 mm                            | 3.0 %  |
| (4) Clay size, smaller than 0.005 mm                        | 4.7 %  |

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*[Signature]* 5/27/93  
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## ENGINEERING-SCIENCE

## CHAIN OF CUSTODY RECORD FOR WATER SAMPLES

ES JOB NO.		PROJECT NAME/LOCATION		PRESERVATIVES REQUIRED												ANALYSES REQUIRED												REMARKS											
W.O. 4996		R. Charbone																										Sequoia Lab											
FIELD CONTACT: R. Charbone																																							
SAMPLER NAMES & SIGNATURES																																							
DATE	TIME	FIELD SAMPLE IDENTIFIER		Particle Size	T. Phosphorus	TKN																																	
4/21/93	1050	K-IW-1-6.0-6.5'		X	X	X																							9304 D25-01										
4/22/93	1736	K-IW-3-4.5-5.0'		X	X	X																							02										
d	1910	K-EW-3-5.0-5.5'		X	X	X																							03										
4/24/93		K-EW-1-4.0-5.0'		X	X	X																							04										
Relinquished By: Eric Vonnard 4/28/93 1200																																							

FIELD CUSTODY RELINQUISHED BY: *R. Charbone* DATE: 4/27/93 TIME: 0745

SHIPPED VIA: AIRBILL # ON RECEIPT: CUSTODY DEALT? °C

RECEIVED FOR LABORATORY BY: S. Charbone 4/28/93 TIME: 11:00

**GC VOLATILES DATA PACKAGE**

GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.: 4990

% Moisture: 10

Client ID: K1-MPA-3.0'-3.5'

Matrix: SOIL

Laboratory ID: 4990-01

Level: MEDIUM

Sample wt./vol : 5 gm

Unit: ug/Kg

Dilution Factor: 20

Date Analyzed: 04-27-93  
Date Confirmed: NA

Compound	Result	(mg/kg)	Detection Limit
Benzene	10000	10	780
Ethyl Benzene	ND	< .8	800
Toluene	12000	12	1200
Xylenes (total)	7600	7.6	2000

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *Am F*GROUP LEADER: *DAH* 5/13/93

Date Analyzed:04-26-93  
Date Confirmed:NA

**GROUP LEADER:**

~~5/13/93~~ 5/13/93

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way  
Berkeley, CA 94710

GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4990

% Moisture: 12

Client ID:K1-VWA-3.0'-3.5'

Matrix:SOIL

Laboratory ID:4990-03

Level:MEDIUM

Sample wt./vol : 5 gm

Unit:ug/Kg

Dilution Factor: 200

Date Analyzed:04-30-93  
Date Confirmed:NA

Compound	Result	<i>mg/kg</i>	Detection Limit
Benzene	ND	48	8000
Ethyl Benzene	48000	48	8200
Toluene	93000	93	12000
Xylenes (total)	340000	340	21000

ND-Not Detected  
NA-Not Applicable  
D-Dilution Factor

ANALYST: *AF*

GROUP LEADER: *AF* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.: 4990

% Moisture: 10

Client ID: K-BG-4.5'-5.0'

Matrix: SOIL

Laboratory ID: 4990-04

Level: LOW

Sample wt./vol : 5.0 g.

Unit: ug/Kg

Dilution Factor: 1

Date Analyzed: 04-30-93

Date Confirmed: NA  
-----

Compound

Result

mg/Kg

Detection  
Limit

Benzene

ND

4.00000

0.66

Ethyl Benzene

ND

1.00000

0.52

Toluene

ND

&lt; .00082

0.82

Xylenes (total)

ND

&lt; .00187

1.87

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *A. F.*GROUP LEADER: *5/17/93*

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4990

% Moisture: 0

Client ID:(BLANK)

Matrix:SOIL

Laboratory ID:MSVG2930426

Level:LOW

Sample wt./vol : 5.0 g.

Unit:ug/Kg

Dilution Factor: 1

Date Analyzed:04-26-93  
Date Confirmed:NA  
-----

Compound

Result

Detection  
Limit  
-----

Benzene

ND

0.59

Ethyl Benzene

ND

0.47

Toluene

ND

0.74

Xylenes (total)

ND

1.68

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *Am f*GROUP LEADER: *AS* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4990

% Moisture: 0

Client ID:(BLANK)

Matrix:SOIL

Laboratory ID:MWVG2930427

Level:MEDIUM

Sample wt./vol : 5 gm

Unit:ug/Kg

Dilution Factor: 1

Date Analyzed:04-27-93  
Date Confirmed:NA-----  
Compound

Result

Detection  
Limit  
-----

Benzene

ND

35

Ethyl Benzene

ND

36

Toluene

ND

53

Xylenes (total)

ND

91

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *AS*GROUP LEADER: *AS* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.: 4990

% Moisture: 0

Client ID: (BLANK)

Matrix: SOIL

Laboratory ID: MSVG2930430

Level: LOW

Sample wt./vol : 5.0 g.

Unit: ug/Kg

Dilution Factor: 1

Date Analyzed: 04-30-93

Date Confirmed: NA  
-----

Compound

Result

Detection  
Limit  
-----

Benzene

ND

0.59

Ethyl Benzene

ND

0.47

Toluene

ND

0.74

Xylenes (total)

ND

1.68

ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: *mf*GROUP LEADER: *RA* 5/13/93

-----  
GC ANALYTICAL REPORT  
Analytical Method  
8020 Aromatic Compounds

Work Order NO.:4990

% Moisture: 0

Client ID:(BLANK)

Matrix:SOIL

Laboratory ID:MWVG2930430

Level:MEDIUM

Sample wt./vol : 5 gm

Unit:ug/Kg

Dilution Factor: 1

Date Analyzed:04-30-93  
Date Confirmed:NA-----

Compound	Result	Detection Limit
Benzene	ND	35
Ethyl Benzene	ND	36
Toluene	ND	53
Xylenes (total)	ND	91

-----ND-Not Detected  
NA-Not Applicable  
D-Dilution FactorANALYST: GROUP LEADER: 

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ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

VOLATILE METHOD BLANK SUMMARY

LAB FILE ID: V2P798 (MSVG2930426)

TIME ANALYZED: 1328

DATE ANALYZED: 04-26-93

MATRIX: SOIL

COLUMN ID: VGC2 VOCOL  
-----

CLIENT ID	LABORATORY NO.	LAB FILE ID.	TIME ANALYZED
BLANK SPIKE	SSVG2930426A	V2P799	1406
BLANK SPIKE DUP	SSVG2930426B	V2P800	1444
K1-MPC-3.0'-3.5'	4990-02	V2P841	1604

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

VOLATILE METHOD BLANK SUMMARY

LAB FILE ID: V2P849 (MSVG2930430)

TIME ANALYZED: 1337

DATE ANALYZED: 04-30-93

MATRIX: SOIL

COLUMN ID: VGC2 VOCOL  
-----

CLIENT ID	LABORATORY NO.	LAB FILE ID.	TIME ANALYZED
-----			
BLANK SPIKE	SSVG2930430A	V2P858	1912
BLANK SPIKE DUP	SSVG2930430B	V2P859	1950
K-BG-4.0'-4.5'	4990-04	V2P852	1459

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

VOLATILE METHOD BLANK SUMMARY

LAB FILE ID: V2P811 (MWVG2930427)

TIME ANALYZED: 1351

DATE ANALYZED: 04-27-93

MATRIX: <sup>Soil PL</sup>~~WATER~~ 5/7/93

COLUMN ID: VGC2 VOCOL

=====

CLIENT ID	LABORATORY NO.	LAB FILE ID.	TIME ANALYZED
K1-MPA-3.0'-3.5'	4990-01	V2P812	1435

=====

600 BANCROFT WAY  
BERKELEY, CA 94710

MATRIX: Soil RE  
~~WATER~~ 5/07/93

CLIENT ID	LABORATORY NO.	LAB FILE ID.	TIME ANALYZED
BLANK SPIKE	SWVG2930430A	V2P856	1756
BLANK SPIKE DUP	SWVG2930430B	V2P857	1834
K1-VWA-3.0'-3.5'	4990-03	V2P855	1641

-----  
ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710  
-----

FORM II VOA-1 (1/87 REV.)  
EPA METHOD 8020

MATRIX: SOIL

COLUMN ID: VGC2 VOCOL

-----  
LABORATORY NO. a-a-a-TriFluoro  
Toluene  
-----

MSVG2930426	101
SSVG2930426A	89
SSVG2930426B	88
4990-02	110
MSVG2930430	113
4990-04	114
SSVG2930430A	91
SSVG2930430B	94

ES-ENGINEERING SCIENCE, INC.

600 BANCROFT WAY  
BERKELEY, CA 94710

FORM II VOA-1 (1/87 REV.)  
EPA METHOD 8020

MATRIX: SOIL (MEDIUM)

COLUMN ID: VGC2 VOCOL

LABORATORY NO. a-a-a-TriFluoro  
Toluene

MWVG2930427	101
4990-01	119
MWVG2930428	90
SWVG2930428A	85
SWVG2930428B	95
MWVG2930430	112
4990-03	109
SWVG2930430A	92
SWVG2930430B	92

**TOTAL RECOVERABLE PETROLEUM HYDROCARBONS  
DATA PACKAGE**

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEEWork Order: 4990  
Matrix: SolidClient's ID: K1-MPA K1-MPC K1-VWA  
-2.5'-3.0' -2.5'-3.0' -2.5'-3.0'

Sample Date: 04/17/93 04/18/93 04/17/93

% Moisture:

Lab ID: 4990.01 4990.02 4990.03

Parameter	-----Results-----	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	300. 120. 370.	SM 403(M)	50	mg/Kg CaCO <sub>3</sub>	05/07/93
Moisture	10.2 12.0 12.3	ASTM D2216	.1	% by wt	04/27/93
pH	7.6 7.3 7.5	EPA 9045	NA	pH Units	04/27/93

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable

ND- Not Detected

ANALYST: Don SkatonGROUP LEADER: [Signature]

## INORGANICS ANALYTICAL REPORT

Client: ES-Denver  
Project: AFCEEWork Order: 4990  
Matrix: SolidClient's ID: K-BG  
-4.0'-4.5'Sample Date: 04/19/93  
% Moisture:  
Lab ID: 4990.04

Parameter	-----Results-----	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	84.	SM 403(M)	50	mg/Kg CaCO <sub>3</sub>	05/07/93
Moisture	10.4	ASTM D2216	.1	% by wt	04/27/93
pH	7.5	EPA 9045	NA	pH Units	04/27/93

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable

ND- Not Detected

ANALYST: Don GleatonGROUP LEADER: 

CASE NARRATIVE  
WORK ORDER NO. 4990  
IRON BY ICP

Client IDs were abridged by the laboratory to facilitate computer entry of analytical data. The following should be used as a reference:

<u>CLIENT ID</u>	<u>ABRIDGED ID</u>
K1-MPA-2.5'-3.0'	MPA3.0
K1-MPC-2.5'-3.0'	MPC3.0
K1-VMA-2.5'-3.0'	VMA3.0
K-BG-4.0'-4.5'	BG-4.5

The serial dilution sample result for iron did not agree with the undiluted result within 10%, and the diluted result was greater than ten times the iron MDL. All iron results in this batch are therefore flagged with "E".

## INORGANIC ANALYSES DATA SHEET

MPA3.0

SDG No. : BG-4.5

Lab Sample ID: 4990.01

Date Sampled : 04/17/93

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

FORM I - IN

## INORGANIC ANALYSES DATA SHEET

MPC3.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

3/90

## INORGANIC ANALYSES DATA SHEET

VWA3.0

Contract: AFCEE

SAS No. :

Lab Sample ID: 4990.03

Date Sampled : 04/17/93

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

## INORGANIC ANALYSES DATA SHEET

BG-4.5

% Solids: 89.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

[illegible]

Comments:

## INORGANIC ANALYSES DATA SHEET

PBLANK

LABORATORY CONTROL SAMPLE (BLANK SPIKE)

Contract: AFCEE

SDG No. : BG-4.5

Aqueous LCS Source: \_\_\_\_\_

FORM VII - IN

LABORATORY CONTROL SAMPLE (BLANK SPIKE)

Contract: AFCEE

SDG No.: BG-4.5 [REDACTED]

**Aqueous LCS Source:**

[illegible]



## EPA SAMPLE NO.

ICP SERIAL DILUTION

Contract: AFCEE

MPB-50L

Case No.: 49745

SAS No. :

SDG No. : BG-4.5.

Level (low/med): LOW

Concentration Units: ug/L

[illegible]

## Method Detection Limits (Annually)

Contract: AFCEE

SDG No. : BG-4.5

08/31/92

Matrix: SOIL

(ug/L in 1.00g to 100ml digestate)

Comments:



Engineering Science - Berkeley Laboratory  
Inorganics Report

ANALYSIS RUN LOG

Lab Name: E\_S\_\_BERKELEY\_LABORATORY\_

Contract: AFCEE\_\_\_\_\_

Lab Code: ESBL\_\_ Case No.: 4974S\_

SAS No.: \_\_\_\_\_ SDG No.: BG-4.5

Instrument ID Number: TJA 61 M\_

Method: P\_

Start Date: 05/06/93

End Date: 05/06/93

EPA Sample No.	D/F	Time	% R	Analytes																	
				F	E																
STD1	1.00	1050		X																	
STD2	1.00	1055		X																	
STD3	1.00	1101		X																	
STD4	1.00	1107		X																	
ICV	1.00	1112		X																	
ICB	1.00	1118		X																	
ICSA	1.00	1124		X																	
ICSAB	1.00	1129		X																	
CRI	1.00	1135																			
ZZZZZZ	1.00	1141																			
PBLANK	1.00	1146		X																	
LCSS	1.00	1152		X																	
LCSSD	1.00	1158		X																	
MPB-50	1.00	1203		X																	
MPB-50L	1.00	1209		X																	
MPA-40	1.00	1214		X																	
CCV	1.00	1220		X																	
CCB	1.00	1226		X																	
MPA3.0	1.00	1231		X																	
MPC3.0	1.00	1237		X																	
VWA3.0	1.00	1243		X																	
BG-4.5	1.00	1248		X																	
MP1-24	1.00	1254		X																	
VW1-30	1.00	1300		X																	
MP2-25	1.00	1305		X																	
MP4-22	1.00	1311		X																	
WH-MPA	1.00	1317		X																	
CCV	1.00	1322		X																	
CCB	1.00	1328		X																	
KIW6.5	1.00	1334		X																	
KIW5.50	1.00	1339		X																	
KEW5.5	1.00	1345		X																	

## ANALYSIS RUN LOG

Contract: AFCEE

SAS No. :                      SDG No. : BG-4.5

Method: P

End Date: 05/06/93

[illegible]



**TOTAL PHOSPHORUS  
TOTAL KJELDAHL NITROGEN  
SOIL CLASSIFICATION  
DATA PACKAGE**



# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: 4990  
Sample Descript: Soil  
Analysis for: Nitrogen:Kjeldahl  
First Sample #: 3DA3901

Sampled: 4/17-4/18/93  
Received: Apr 22, 1993  
Analyzed: Apr 26, 1993  
Reported: May 25, 1993

## LABORATORY ANALYSIS FOR: Nitrogen:Kjeldahl

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
3DA3901	4990.01C	20	76
3DA3902	4990.02C	20	130
3DA3903	4990.3C	20	99
3DA3904	4990.4C	20	69

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5/25/93

ESBL PROJECT MANAGER  
PACE

DATE

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Jennifer A. Nelson  
Project Manager

**Please Note:**

Sample results are reported on a dry weight basis. % moistures faxed by client 5/14/93.



# SEQUOIA ANALYTICAL

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(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: 4990  
Sample Descript: Soil  
Analysis for: Phosphorus  
First Sample #: 3DA3901

Sampled: 4/17-4/18/93  
Received: Apr 22, 1993  
Analyzed: May 21, 1993  
Reported: May 25, 1993

## LABORATORY ANALYSIS FOR: Phosphorus

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
3DA3901	4990.01C	10	200
3DA3902	4990.02C	10	220
3DA3903	4990.3C	10	150
3DA3904	4990.4C	10	260

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5/25/93

ESBC PROJECT MANAGER  
PAGE

DATE

Analytes reported as N.D. were not present above the stated limit of detection.

## SEQUOIA ANALYTICAL

Jennifer A. Nelson  
Project Manager

### Please Note:

Sample results are reported on a dry weight basis. % moistures faxed by client 5/14/93.  
Samples were analyzed by 365.3 but due to matrix interference were reanalyzed by 365.2.



# SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063  
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.  
600 Bancroft Way  
Berkeley, CA 94710  
Attention: Tom Paulson

Client Project ID: 4990  
Matrix: Soil

QC Sample Group: 3DA3901-04

Reported: May 25, 1993

## QUALITY CONTROL DATA REPORT

### ANALYTE

	TKN	Phosphorus
Method:	351.4	365.2
Analyst:	N. Northey	K. Follett
Conc. Spiked:	4000	0.50
Units:	mg/kg	mg/kg
LCS Batch#:	LCS042693	LCS052193
Date Prepared:	4/26/93	5/21/93
Date Analyzed:	4/26/93	5/21/93
Instrument I.D.#:	N/A	N/A
LCS % Recovery:	84	100
Control Limits:	80-120	80-120

MS/MSD Batch #:	3DA3904	3E65303
Date Prepared:	4/26/93	5/21/93
Date Analyzed:	4/26/93	5/21/93
Instrument I.D.#:	N/A	N/A
Matrix Spike % Recovery:	100	93
Matrix Spike Duplicate % Recovery:	100	83
Relative % Difference:	0.0	11

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 5/25/93  
ESB PROJECT MANAGER DATE  
FACE

SEQUOIA ANALYTICAL

  
Jennifer A. Nelson  
Project Manager

#### Please Note:

The LCS is a control sample of known, interferent free matrix that is analyzed using the same reagents, preparation and analytical methods employed for the samples. The LCS % recovery data is used for validation of sample batch results. Due to matrix effects, the QC limits for MS/MSD's are advisory only and are not used to accept or reject batch results.

3DA3901.ENG <3>

# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/18/93

Lab ID: 9304A39-01

Client ID: 4990.01C

Sample Descri SOIL

### SIEVE TEST

A. Total weight of sample:

155.5 g

B. Weight retained in No.10 sieve:

3.4 g

C. % passing No.10 sieve:

97.81 %

Sieve test for weight  
retained in a No.10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	3.40	2.19	2.19	97.81
No. 200	112.90	72.60	74.79	25.21

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (M)	CORRECTED READING (R)	(L)	PARTICLE DIAM. in mm (S)
2	21	17	13	14.2	0.0359
5	21	17	13	14.2	0.0227
10	21	16	12	14.3	0.0161
15	21	16	12	14.3	0.0132
25	21	15	11	14.5	0.0103
40	21	15	11	14.5	0.0081
60	21	14	10	14.7	0.0067
90	21	14	10	14.7	0.0054
120	21	14	10	14.7	0.0047
1440	21	13	9	14.8	0.0014

% SUSPENDED (P)
20.4
20.4
18.8
18.8
17.2
17.2
15.7
15.7
15.7
14.1

Weight of soil used in hydrometer test (D):

65 g

Hydrosopic moisture correction factor (G):

0.96

Specific gravity (Assumed):

2.65

Dispersing agent correction factor (E):

3

Meniscus correction factor (F):

1

Temp./Spec. gravity dependant constant (K):

0.01348

Formulas:

$$R = H - E - F$$

$$S = K[\text{SQRT}(L/T)]$$

$$P = (R/W)100$$

$$W = (J \times 100)/C$$

$$J = D \times G$$

THIS REPORT HAS BEEN  
APPROVED AND REVIEWED BY

*Diane G. Gave*

*RL*

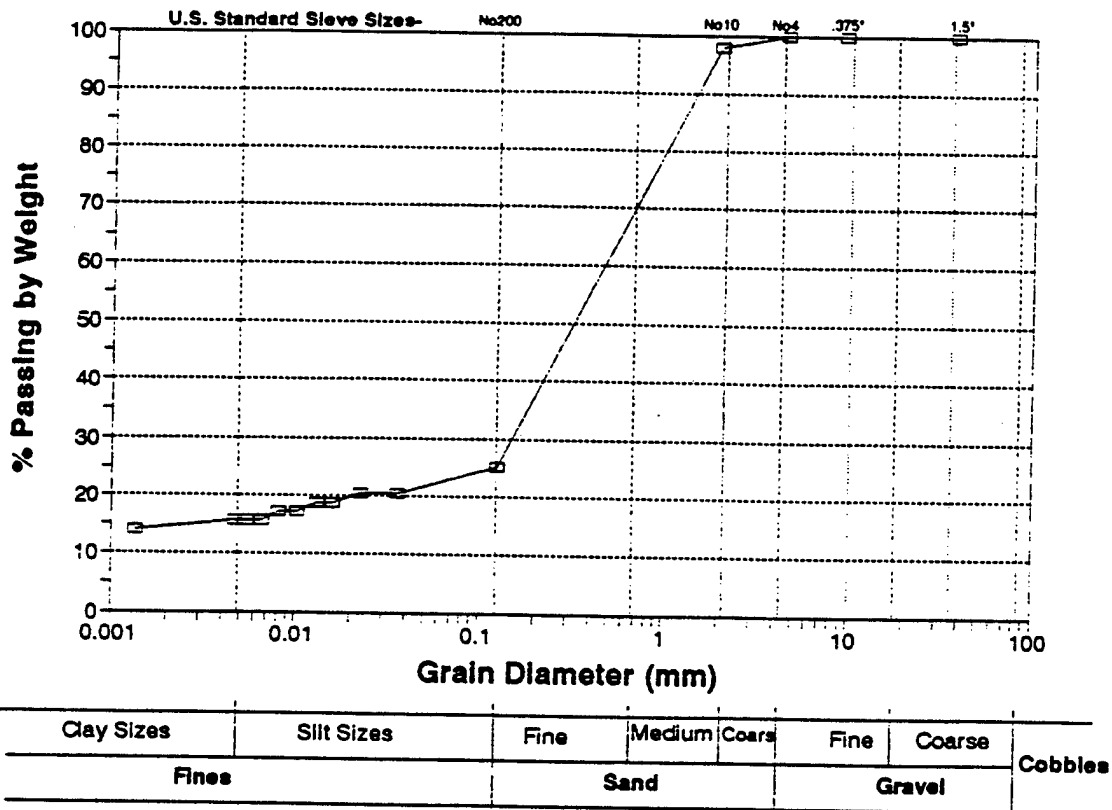
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PACE

DATE

Method: ASTM D422-63  
 Analyzed: 5/18/93  
 Lab ID: 9304A39-01

### Graph of Acquired Data



Graphing Data:	
Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	97.61
0.127	25.21
0.0359	20.38
0.0227	20.38
0.0161	18.81
0.0132	18.81
0.0103	17.24
0.0081	17.24
0.0067	15.68
0.0054	15.68
0.0047	15.68
0.0014	14.11

#### Sample Composition:

- |   |        |
|---|--------|
| (1) Gravel, passing 3-in. and retained on No. 4 sieve       | 0.0 %  |
| (2) Sand, passing No. 4 sieve and retained on No. 200 sieve | 77.0 % |
| (3) Silt size, 0.074 to 0.005 mm                            | 7.3 %  |
| (4) Clay size, smaller than 0.005 mm                        | 15.7 % |

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*[Signature]*

5/25/93

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 PACE

DATE

# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/18/93

Lab ID: 9304A39-02

Client ID: 4990.02C

Sample Descr SOIL

### SIEVE TEST

A. Total weight of sample:

229.11 g

B. Weight retained in No.10 sieve:

6.1 g

C. % passing No.10 sieve:

97.34 %

Sieve test for weight retained in a No.10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	6.10	2.66	2.66	97.34
No. 200	190.30	83.06	85.72	14.28

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. in mm (S)
2	21	13	9	14.8	0.0367
5	21	13	9	14.8	0.0232
10	21	12	8	15	0.0165
15	21	11	7	15.2	0.0136
25	21	10	6	15.3	0.0105
40	21	10	6	15.3	0.0083
60	21	10	6	15.3	0.0068
90	21	9	5	15.5	0.0056
120	21	9	5	15.5	0.0048
1440	21	8	4	15.6	0.0014

% SUSPENDED (P)
13.8
13.8
12.2
10.7
9.2
9.2
9.2
7.6
7.6
6.1

Weight of soil used in hydrometer test (D):

65 g

Hydrosopic moisture correction factor (G):

0.98

Specific gravity (Assumed):

2.65

Dispersing agent correction factor (E):

3

Meniscus correction factor (F):

1

Temp./Spec. gravity dependant constant (K):

0.01348

Formulas:

$$R = H - E - F$$

$$S = K[\text{SQRT}(L/T)]$$

$$P = (R/W)100$$

$$W = (J \times 100)/C$$

$$J = D \times G$$

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*BB*

5/25/93

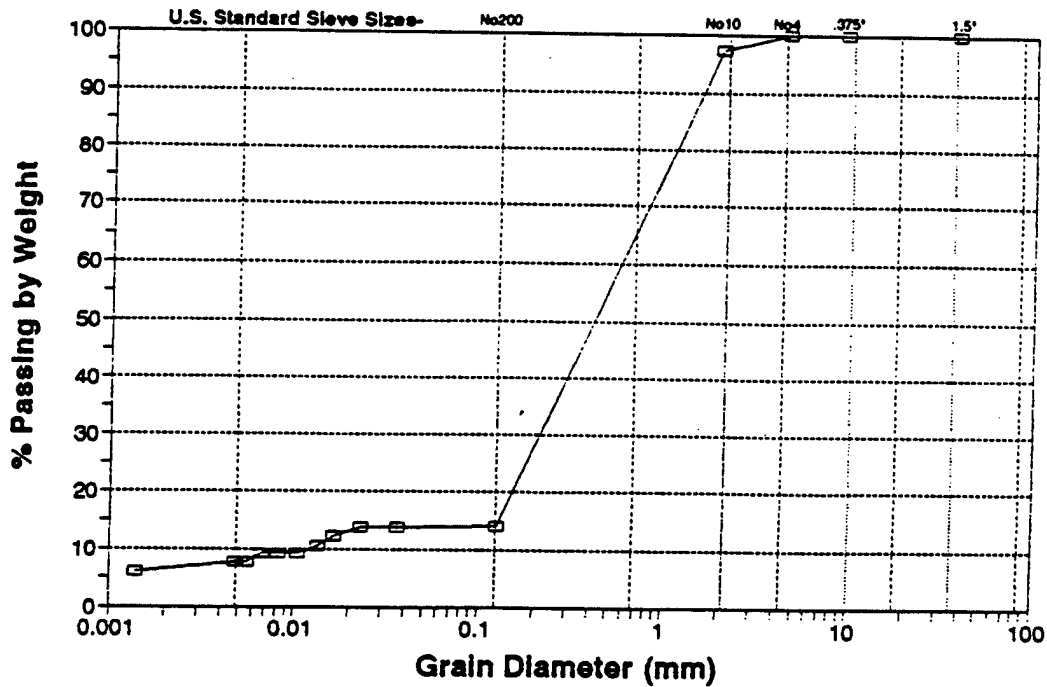
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DATE

*K. J. Lawrence*

Method: ASTM D422-83  
 Analyzed: 5/18/93  
 Lab ID: 9304A39-02

## Graph of Acquired Data



Clay Sizes	Silt Sizes	Fine	Medium	Coarse	Fine	Coarse	Cobbles
Fines		Sand			Gravel		

Graphing Data:	
Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	97.34
0.127	14.28
0.0367	13.75
0.0232	13.75
0.0165	12.22
0.0136	10.70
0.0105	9.17
0.0083	9.17
0.0068	9.17
0.0056	7.64
0.0048	7.64
0.0014	6.11

### Sample Composition:

(1) Gravel, passing 3-in. and retained on No. 4 sieve	0.0 %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve	88.4 %
(3) Silt size, 0.074 to 0.005 mm	4.0 %
(4) Clay size, smaller than 0.005 mm	7.6 %

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*[Signature]*

5/25/93

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 PACE

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*[Signature]*

# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/19/93

Lab ID: 9304A39-03

Client ID: 4990.3C

Sample Description: SOIL

### SIEVE TEST

A. Total weight of sample:

226.73 g

B. Weight retained in No.10 sieve:

2.4 g

C. % passing No.10 sieve:

98.94 %

Sieve test for weight  
retained in a No.10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	2.40	1.06	1.06	98.94
No. 200	194.56	85.81	86.87	13.13

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. in mm (S)
2	21	12	8	15	0.0369
5	21	9	5	15.5	0.0237
10	21	9	5	15.5	0.0168
15	21	9	5	15.5	0.0137
25	21	9	5	15.5	0.0106
40	21	8	4	15.6	0.0084
60	21	8	4	15.6	0.0069
90	21	8	4	15.6	0.0056
120	21	7	3	15.8	0.0049
1440	21	7	3	15.8	0.0014

% SUSPENDED (P)
12.4
7.8
7.8
7.8
7.8
6.2
6.2
6.2
4.7
4.7

Weight of soil used in hydrometer test (D):

Hydroscopic moisture correction factor (G):

Specific gravity (Assumed):

Dispersing agent correction factor (E):

Meniscus correction factor (F):

Temp./Spec. gravity dependant constant (K):

65 g
0.98
2.65
3
1
0.01348

Formulas:

$$R = H - E - F$$

$$S = K[\text{SQRT}(L/T)]$$

$$P = (R/W)100$$

$$W = (J \times 100)/C$$

$$J = D \times G$$

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PROJECT MANAGER

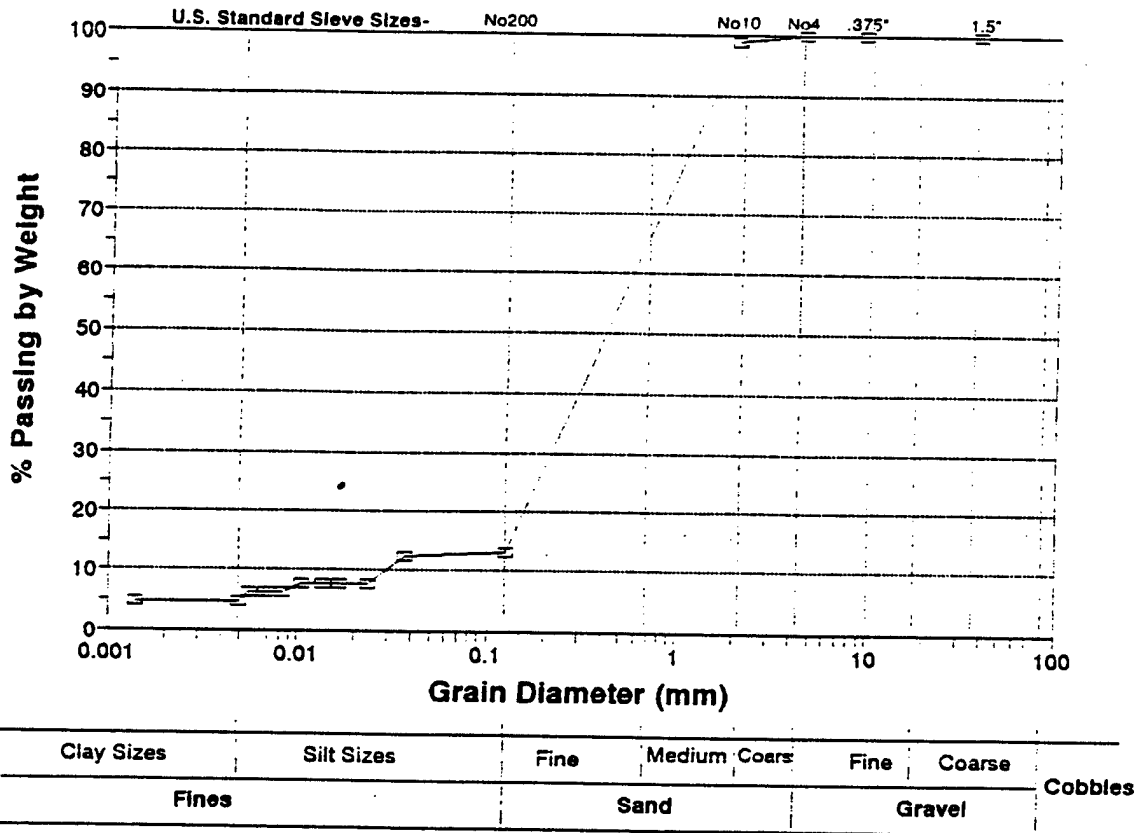
DATE

*Diane Souver*

*RB*

5/25/93

## Graph of Acquired Data



### Graphing Data:

Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	98.94
0.127	13.13
0.0369	12.43
0.0237	7.77
0.0168	7.77
0.0137	7.77
0.0106	7.77
0.0084	6.21
0.0069	6.21
0.0056	6.21
0.0049	4.66
0.0014	4.66

### Sample Composition:

(1) Gravel, passing 3-in. and retained on No. 4 sieve	0.0 %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve	87.9 %
(3) Silt size, 0.074 to 0.005 mm	7.4 %
(4) Clay size, smaller than 0.005 mm	4.7 %

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*BB*

5/25/93

ES21  
PAGE PROJECT MANAGER

DATE

*Diane Sawyer*

# SEQUOIA ANALYTICAL LABORATORY

## Particle Size Distribution by Sieve and Hydrometer

Method: ASTM D422-63

Analyzed: 5/19/93

Lab ID: 9304A39-04

Client ID: 4990.4c

Sample Description: SOIL

### SIEVE TEST

A. Total weight of sample:

170.48 g

B. Weight retained in No.10 sieve:

0 g

C. % passing No.10 sieve:

100.00 %

Sieve test for weight  
retained in a No.10 sieve.

SIEVE SIZE	WEIGHT RETAINED(g)	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1 1/2 in	0.00	0.00	0.00	100.00
3/8 in	0.00	0.00	0.00	100.00
No. 4	0.00	0.00	0.00	100.00
No. 10	0.00	0.00	0.00	100.00
No. 200	143.54	84.20	84.20	15.80

### HYDROMETER TEST

ELAPSED TIME (min)	TEMP. (deg C)	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. in mm (S)
2	21	13	9	14.8	0.0367
5	21	12	8	15	0.0233
10	21	12	8	15	0.0165
15	21	12	8	15	0.0135
25	21	12	8	15	0.0104
40	21	12	8	15	0.0083
60	21	11	7	15.2	0.0068
90	21	11	7	15.2	0.0055
120	21	10	6	15.3	0.0048
1440	21	9	5	15.5	0.0014

% SUSPENDED (P)
14.1
12.6
12.6
12.6
12.6
12.6
11.0
11.0
9.4
7.8

Weight of soil used in hydrometer test (D):

65 g

Hydroscopic moisture correction factor (G):

0.98

Specific gravity (Assumed):

2.65

Dispersing agent correction factor (E):

3

Meniscus correction factor (F):

1

Temp./Spec. gravity dependant constant (K):

0.01348

Formulas:

$$R = H - E - F$$

$$S = K[\text{SQRT}(L/T)]$$

$$P = (R/W)100$$

$$W = (J \times 100)/C$$

$$J = D \times G$$

THIS REPORT HAS BEEN  
APPROVED AND REVIEWED BY

*Diane Sawyer*

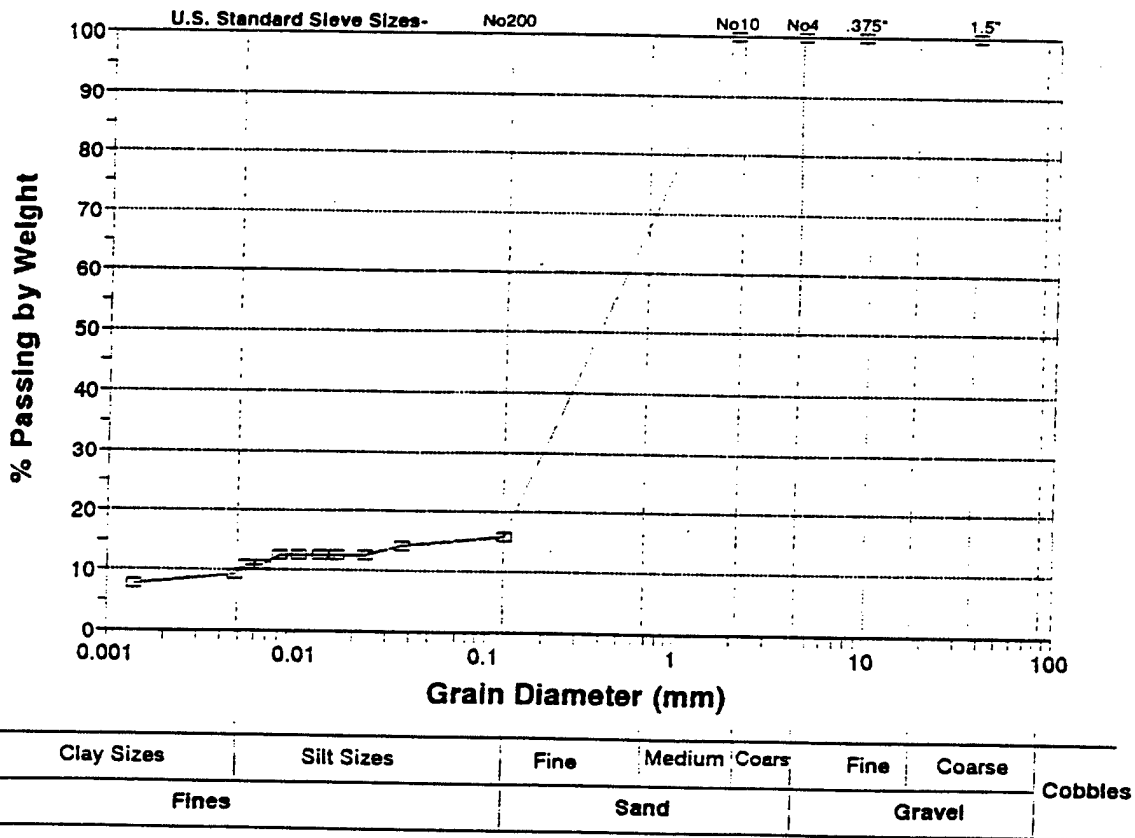
*RB*

5/25/93

SSA PROJECT MANAGER

DATE

## Graph of Acquired Data



### Graphing Data:

Part. Diam. (mm)	Percent Suspended
37.5	100.00
9.5	100.00
4.5	100.00
2	100.00
0.127	15.80
0.0367	14.13
0.0233	12.56
0.0165	12.56
0.0135	12.56
0.0104	12.56
0.0083	12.56
0.0068	10.99
0.0055	10.99
0.0048	9.42
0.0014	7.85

### Sample Composition:

(1) Gravel, passing 3-in. and retained on No. 4 sieve	0.0 %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve	84.2 %
(3) Silt size, 0.074 to 0.005 mm	6.4 %
(4) Clay size, smaller than 0.005 mm	9.4 %

THIS REPORT HAS BEEN  
 APPROVED AND REVIEWED BY

*[Signature]*

5/25/93

PROJECT MANAGER  
 PACE

DATE

*[Signature]*

# CLAIM OF CUSTODY RECORD FOR WATER SAMPLES

PROJECT NAME/LOCATION	DATE	TIME	FIELD SAMPLE IDENTIFIER	ANALYSES REQUIRED	PRESERVATIVES REQUIRED
4990	17/93	1330	K1-NPA-2.5'-3.0' (4990.01 c)	E 3512 (TKN) X	
	18/93	1025	K1-NPC-2.5'-3.0' (4990.02 c)	E 365.3 (PHE) X	
	17/93	↓	K1-NPC-2.5'-3.0' (4990.03 c)	UCM (CLASS) X	
	17/93	1430	K1-NWA-2.5'-3.0' (4990.04 c)		
	9/93		K-BG-4.0'-4.5' (4990.05 c)		
FIELD CONTACT:				REMARKS	
SAMPLER NAMES & SIGNATURES				TO: SEQUOIA LAB.	
Relinquished By: Sam Vann				REPORT TO: TONY PAULSEN - EOR	
4/22/93 1115				4/22/93 1115	

WLD COUNTRY RELINQUISHED BY:

DATE: 4/24/2013 TIME: 1400

ИЗДАНИЕ

ANIRULI, H

DO NOT RECEIPT: CUSTOMER SERVICE

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**APPENDIX C**  
**AOC A SOIL GAS PERMEABILITY DATA**

**Table C-1. Results of Soil Gas Permeability Test at Monitoring Point K1-MPA**

Time (Minutes)	Pressure ("H <sub>2</sub> O) by Depth		
	3.0'	5.0'	7.0'
0	0	0	0
1	0.17	0.24	0.25
2	0.30	0.35	0.35
3	0.39	0.40	0.43
4	0.45	0.47	0.49
5	0.50	0.54	0.55
6	0.56	0.57	0.59
7	0.61	0.61	0.62
8	0.65	0.67	0.69
9	0.69	0.70	0.70
10	0.70	0.70	0.70
12	0.72	0.74	0.74
14	0.73	0.74	0.74
16	0.75	0.75	0.75
18	0.75	0.75	0.75
20	0.80	0.80	0.80
23	0.79	0.80	0.80
26	0.80	0.80	0.80
29	0.80	0.80	0.80

**Table C-2. Results of Soil Gas Permeability Test at Monitoring Point K1-MPB**

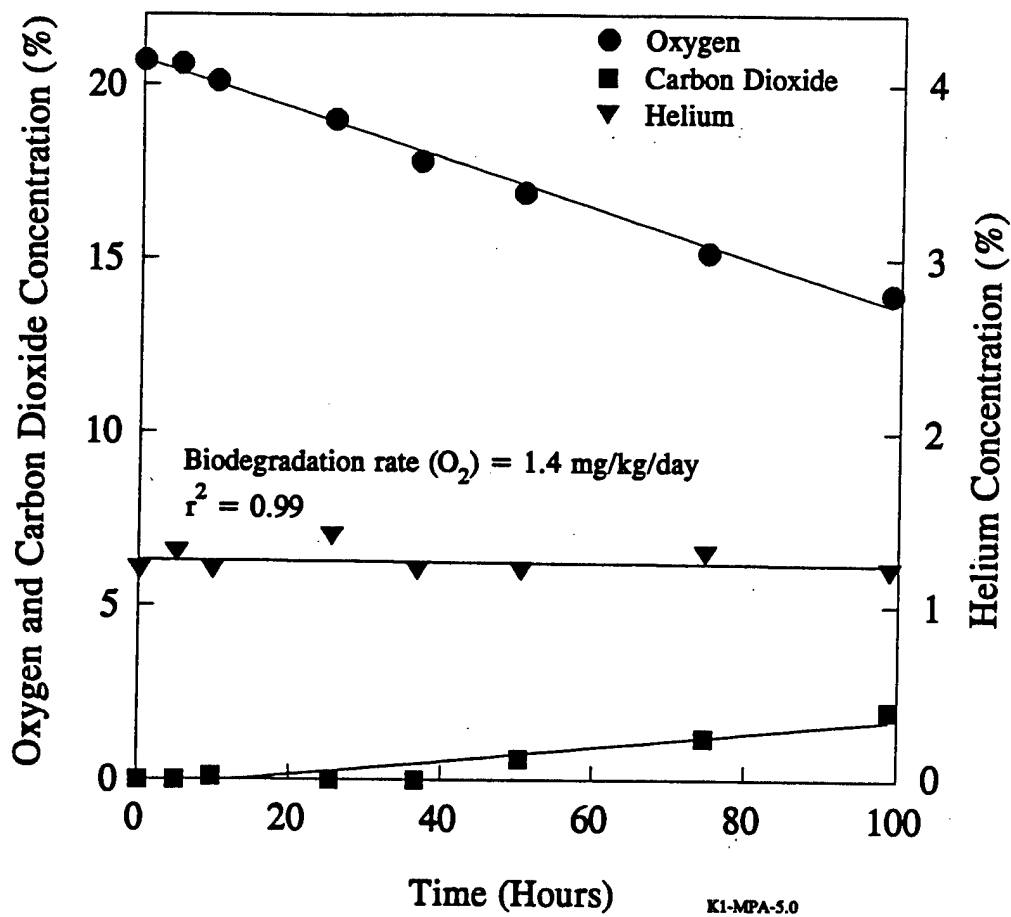
Time (Minutes)	Pressure ("H <sub>2</sub> O) by Depth		
	2.5'	4.0'	7.0'
0	0	0	0
1	0.01	0.03	0.035
2	0.08	0.13	0.14
3	0.15	0.24	0.245
4	0.20	0.25	0.25
5	0.30	0.35	0.35
6	0.35	0.40	0.40
7	0.40	0.45	0.45
8	0.40	0.45	0.45
9	0.45	0.48	0.50
10	0.44	0.49	0.50
12	0.45	0.50	0.50
14	0.50	0.50	0.50
16	0.50	0.54	0.55
18	0.50	0.55	0.55
20	0.55	0.62	0.63
23	0.55	0.60	0.60
26	0.55	0.60	0.60
29	0.55	0.60	0.60

**Table C-3. Results of Soil Gas Permeability Test at Monitoring Point K1-MPC**

Time (Minutes)	Pressure ("H <sub>2</sub> O) by Depth		
	3.0'	5.0'	7.0'
0	0	0	0
1	0.40	0.45	0.46
2	0.65	0.70	0.68
3	0.75	0.75	0.75
4	0.80	0.80	0.78
5	0.81	0.84	0.84
6	0.85	0.85	0.84
7	0.85	0.85	0.85
8	0.85	0.85	0.85
9	0.85	0.85	0.85
11	0.85	0.85	0.85
22	0.87	0.87	0.86
26	0.87	0.87	0.86
30	0.87	0.87	0.87

**APPENDIX D**

**AOC A IN SITU RESPIRATION TEST DATA**



**Figure D-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K1-MPA-5.0'**

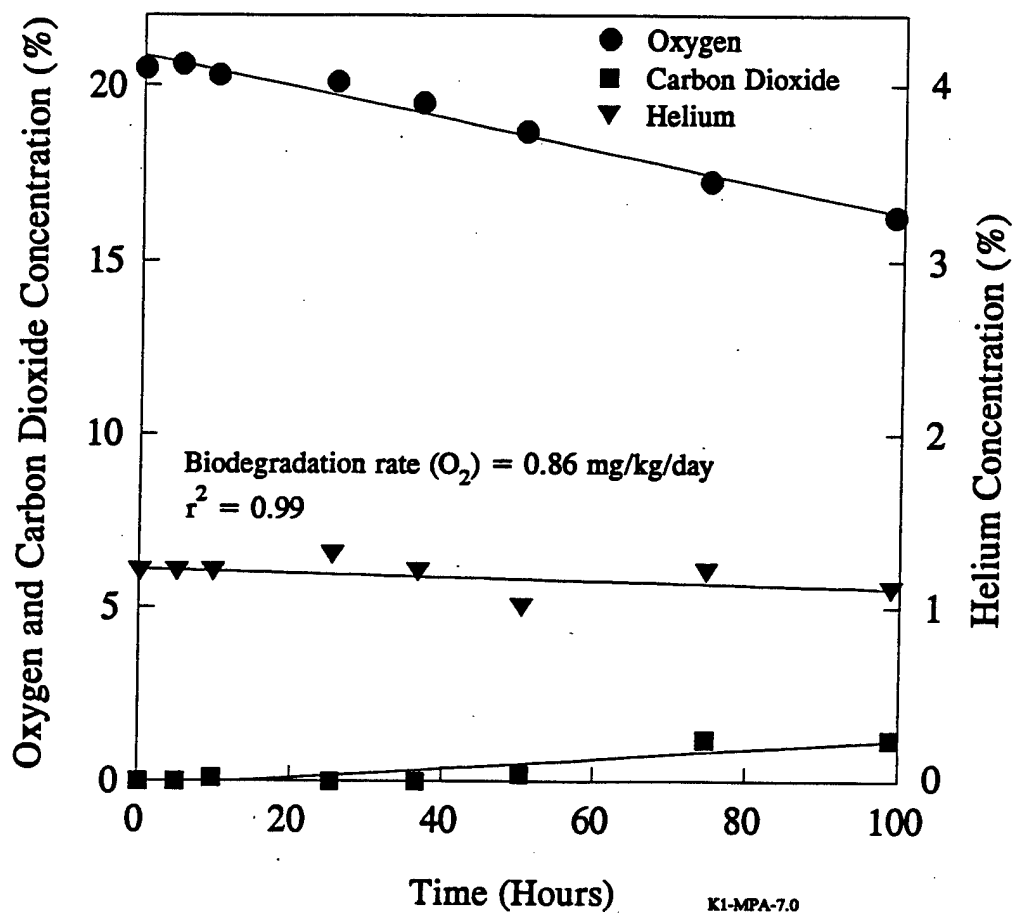
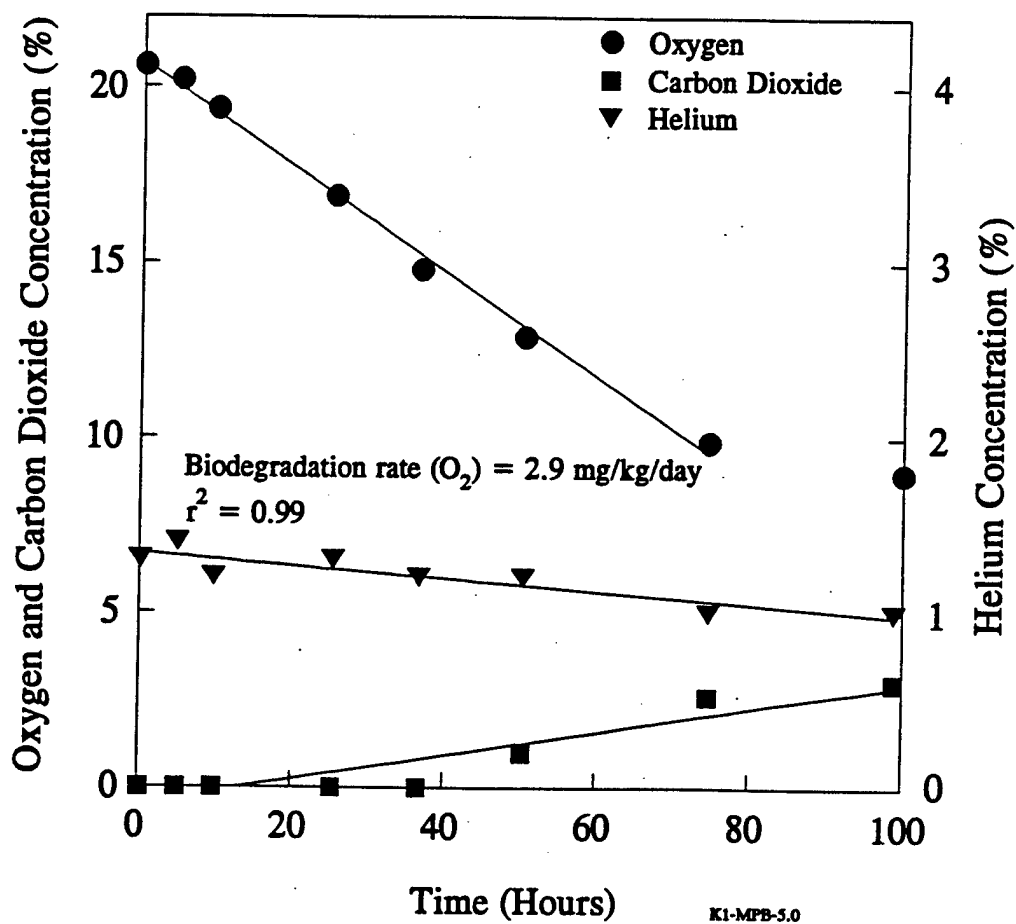


Figure D-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K1-MPA-7.0'



**Figure D-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K1-MPB-5.0'**

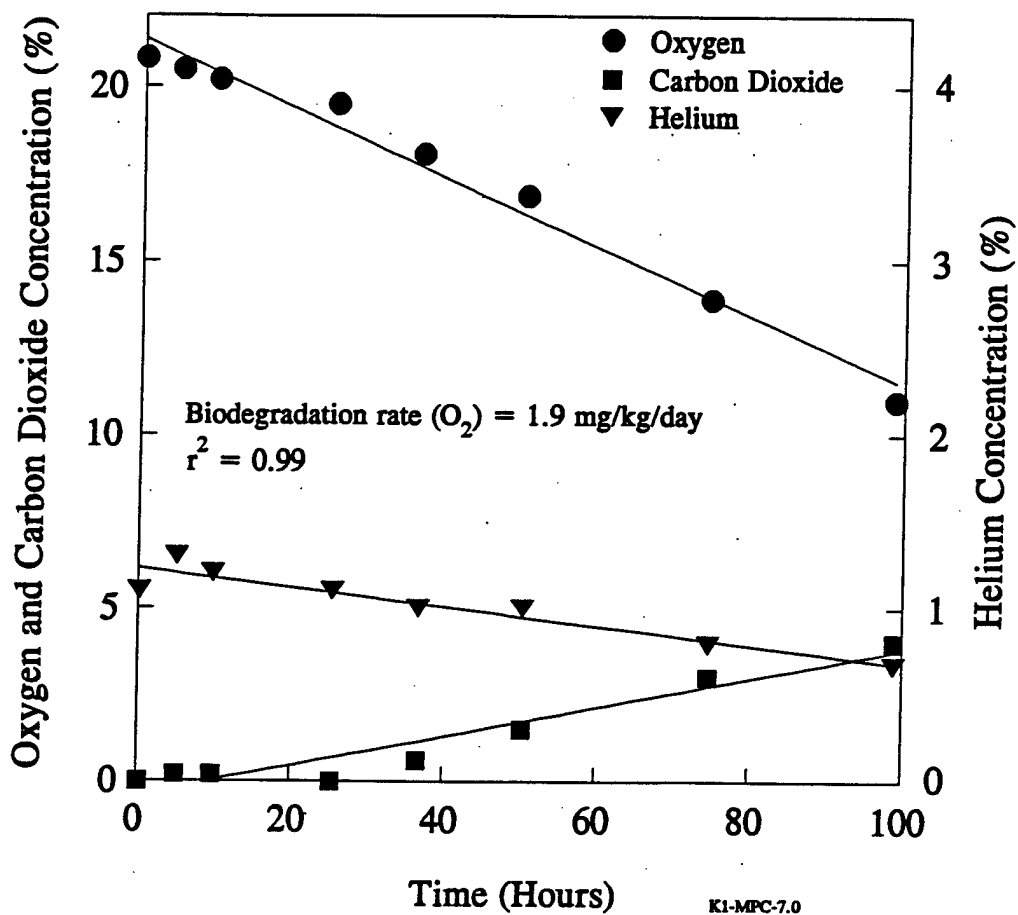


Figure D-4. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K1-MPC-7.0'

**APPENDIX E**

**SWMU 66 SOIL GAS PERMEABILITY DATA**

**Table E-1. Results of Soil Gas Permeability Test at Monitoring Point K2-MPA**

Time (Minutes)	Pressure ("H <sub>2</sub> O) by Depth
	3.0'
0	0
1	2.4
2.5	3.5
3	3.7
4	3.9
5	4.0
6	4.0
7	4.1
8	4.1
10	4.1
12	4.2
14	4.2
16	4.2
18	4.2
20	4.2
25	4.2
30	4.2
35	4.2
45	4.2
60	4.2

**Table E-2. Results of Soil Gas Permeability Test at Monitoring Point K2-MPB**

Time (Minutes)	Pressure ("H <sub>2</sub> O) by Depth
	3.0'
0	0
1	0.06
2	0.35
3	0.60
4	0.76
5	0.93
6	1.0
7	1.05
8	1.13
9	1.15
10	1.17
12	1.25
14	1.27
16	1.30
18	1.31
20	1.32
23	1.35
26	1.39
29	1.39
34	1.47
39	1.53
49	1.57
59	1.57

**Table E-3. Results of Soil Gas Permeability Test at Monitoring Point K2-MPC**

Time (Minutes)	Pressure ("H <sub>2</sub> O) by Depth
	3.0'
0	0
1	0.01
2	0.02
3	0.03
4	0.04
5	0.09
6	0.095
7	0.105
8	0.115
9	0.115
10	0.10
12	0.08
14	0.075
16	0.075
18	0.07
20	0.07
23	0.08
26	0.085
29	0.07
34	0.01
39	0
49	0
59	0.055
60	0

**APPENDIX F**

**SWMU 66 IN SITU RESPIRATION TEST DATA**

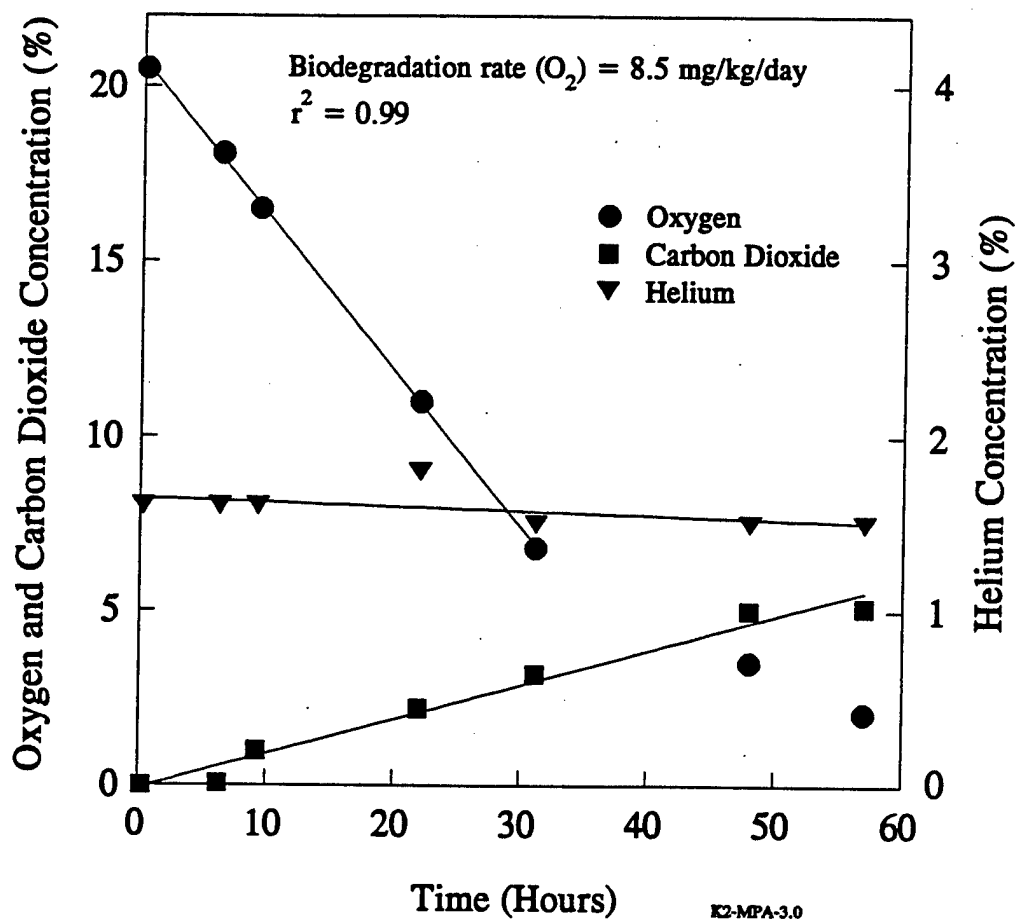


Figure F-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K2-MPA-3.0'

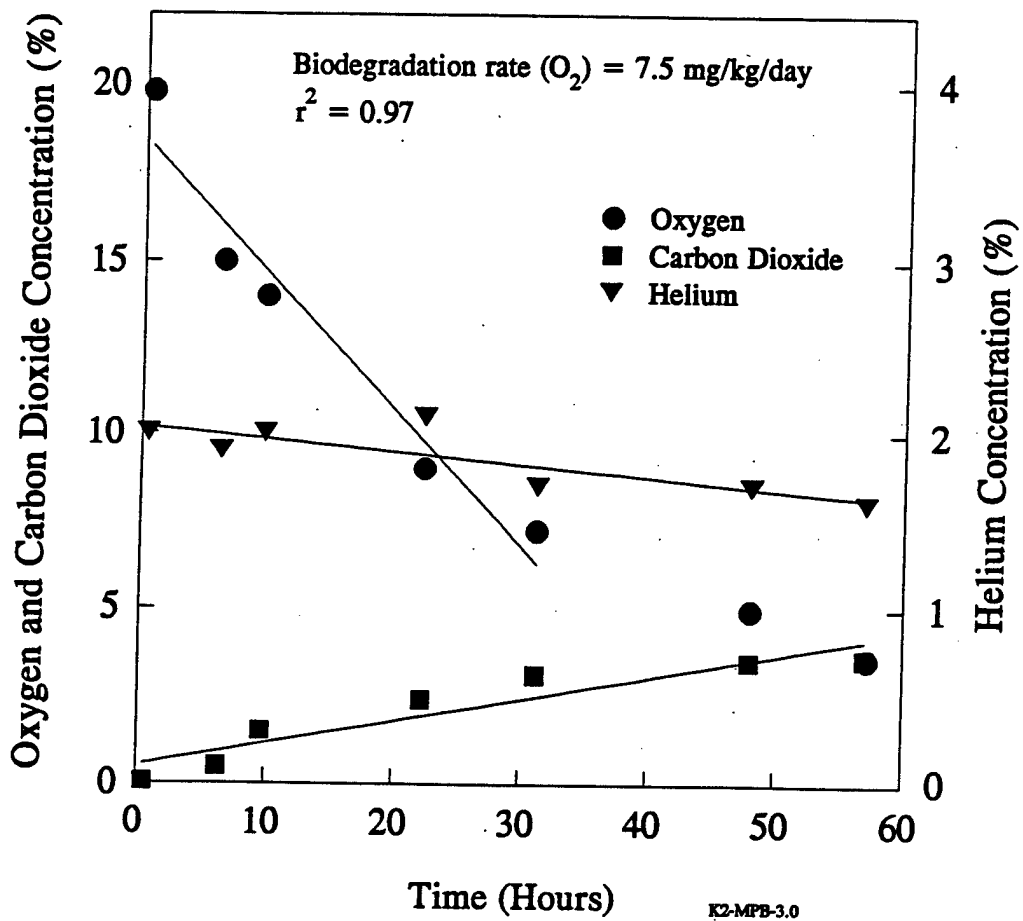
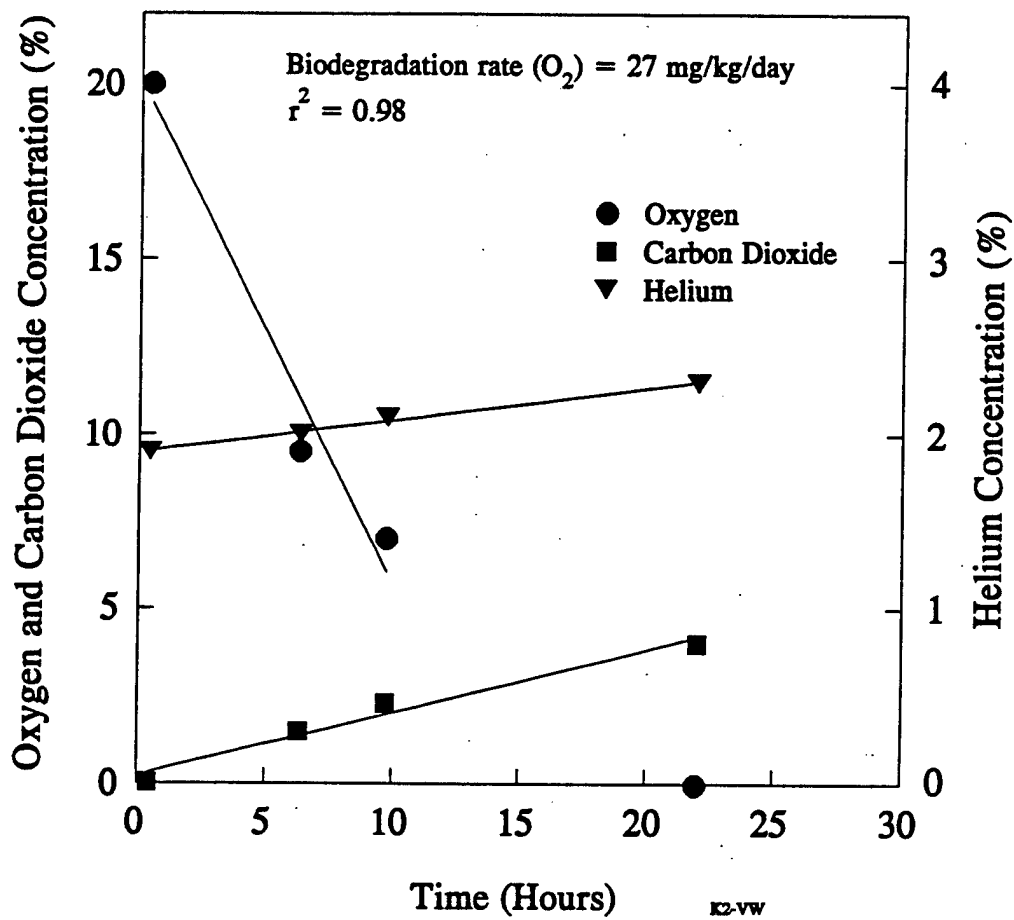
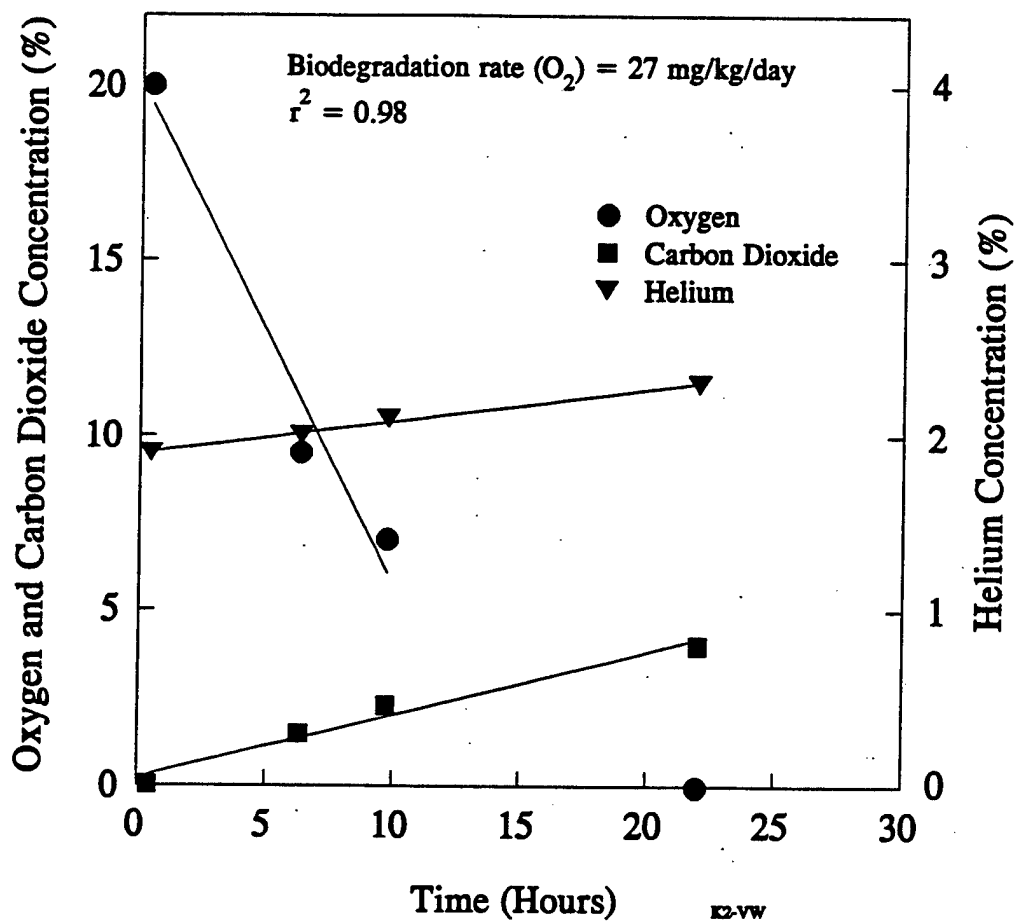


Figure F-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point K2-MPB-3.0'



**Figure F-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at the Vent Well**



**Figure F-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at the Vent Well**